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F01 Workbook - Module 2

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Workbook - Module 2

Model: F01/F02

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

- Understand the changes to the front and rear suspension systems on the new 7 Series
- Understand the changes to chassis dynamics systems on the new 7 Series
- Locate and identify components of the Integrated Chassis Management
- Understand the operation of DCC and ACC Stop and Go.

Chassis and Suspension

Through intelligent design layout and optimum package space utilization on the new F01/F02, the basis has been created for distinctly increasing the driving dynamics while improving comfort and vehicle handling.

At virtually identical wheel loads, a greater track width and a larger wheelbase have been realized compared to the predecessor, the E65.

The development of the new generation chassis and suspension systems in the new F01/F02 focused on revolution instead of evolution. The aim was to set a new benchmark.

The lightweight construction philosophy was consistently pursued in the design of the chassis and suspension systems.

This is reflected in the widespread use of aluminum, representing an important contribution to increasing comfort and reducing CO2 emissions.

For the first time, a BMW Sedan is fitted with a double wishbone front axle made of aluminum, a steerable integral-V rear axle, BMW integral active steering (IAL) and the innovative damper system, the 2nd generation vertical dynamics control (VDC 2).

The integrated chassis management (ICM) intelligently links all chassis and suspension control systems, thus achieving a new level of functional quality. Further highlights include "Dynamic Drive" (ARS) and a fully variable power steering pump to improve fuel economy.

	E65/E66	F01/F02
Front Axle	Double pivot spring strut front axle	Double wishbone front axle
Suspension/damping, front	Steel spring/EDC	Steel spring/VDC 2
Stabilizer bar, front	Passive or Active (ARS)	Passive or Active (ARS)
Rear axle	Integral IV	Integral V
Suspension/damping, rear	Steel spring or Air spring/EDC	Steel spring or Air spring (VDC2)
Stabilizer bar, rear	Passive or Active (ARS)	Passive or Active (ARS)
Brake, front	Disc brake with rotor diameter of 348mm	Disc brake with rotor diameter of 373mm
Brake, rear	Disc brake with rotor diameter of 345mm	Disc brake with rotor diameter of 368mm
Parking brake	Drum brake with EMF	Drum brake with EMF
Wheels/tires	Standard tires	Runflat tires (as standard)
Steering	Power steering (w /Servotronic)	Power steering with Servotronic (optional IAL)

Front Axle

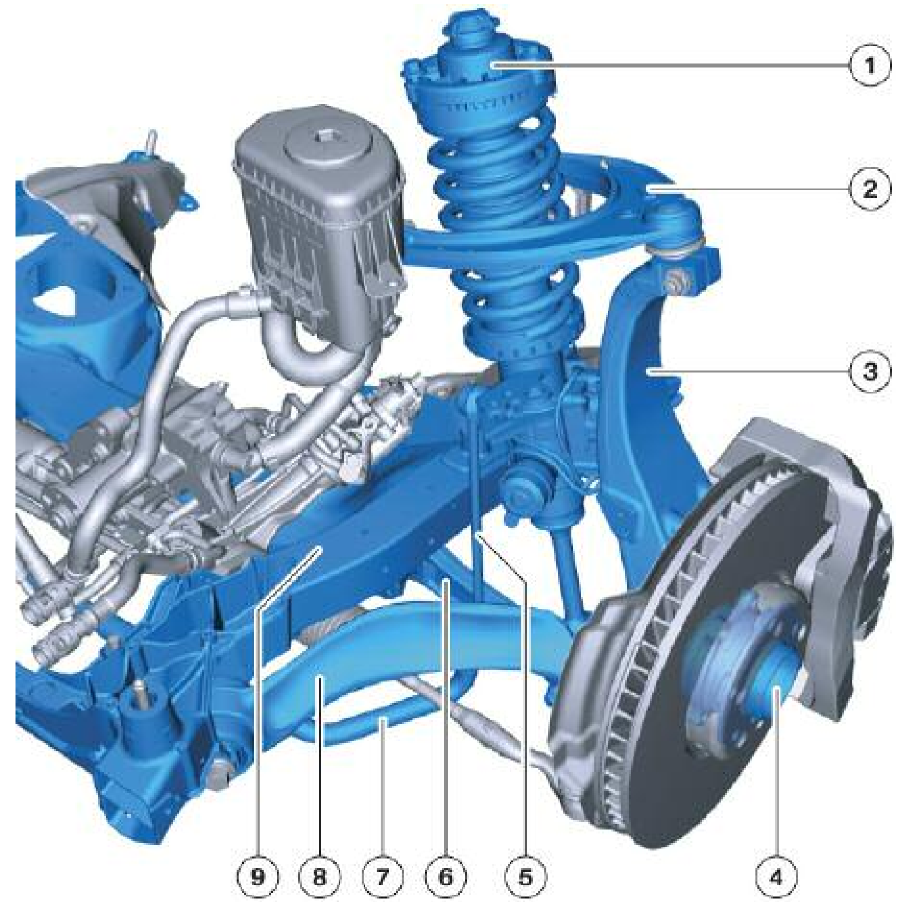
A double wishbone front axle as known from the E70 and E71 is now also fitted in the F01/F02.

In comparison with the double pivot spring strut front axle on the E65, this front axle design offers the following advantages:

- Higher transverse acceleration is reflected in greater vehicle agility.
- Improved cornering/steering and transition characteristics which are particularly favorable in terms of rolling motion.
- Reduced interference means greater comfort.
- Shock absorbers that are subjected to virtually no transverse forces provide greater comfort.
- The design layout of the double wishbone front axle facilitates vertical dynamics control (VDC) and all-wheel drive (as on the E70/E71) without the need to adjust height and no spring travel loss.
- Double wishbone front axles improve directional stability.

The outstanding driving dynamics, the excellent driving comfort as well as the exceptional directional stability are factors of this double wishbone front axle design solution that contribute to a high degree of driving pleasure and safety while making the vehicle ideal for every day use and providing the most relaxing drive on long journeys.

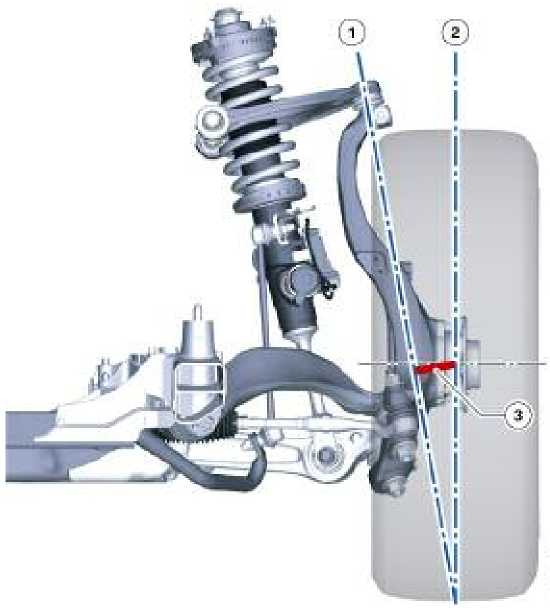
The introduction of a second control arm level for wheel control, which is arranged above the wheel, results in additional degrees of freedom for the kinematics of the front axle as well as for the suspension/damping compared to other designs such as a spring strut front axle.



Index	Explanation	Index	Explanation
1	Spring strut	6	Transverse control arm, bottom
2	Transverse control arm, top	7	Stabilizer bar
3	Swivel bearing	8	Tension strut with hydraulic mount
4	Wheel bearing	9	Front suspension, subframe
5	Stabilizer link		

Virtual Pivot Point

The steering pivot axis (1) of the wheel suspension is now formed by a joint at the top A-arm and the virtual pivot point of the lower arm. This allows the steering pivot axis to be positioned in such a way as to produce a small kingpin offset at hub (3) with sufficient weight recoil.



Description (Front axle data)	E65/E66	F01/F02
Kingpin offset at hub (mm)	**88.1**	**56.3**
Track width (mm)	1578	1611
Camber	-0° 20' ±20'	-0° 12' ±15'
Camber difference	0° ±30'	0° ±30'
Total toe-in	10' ±8'	16' ± 6'
Turning circle (**m**/ft)	**11.92**/39.10	**12.15**/39.86
Kingpin offset (mm)	0	0.5
Toe angle difference (toe out on turns)	1° 27' ±30'	12° 20'
Caster angle	7° 27' ± 30'	7° 0'

This kingpin offset at hub is a direct influence on the scrub radius which is decisive for transmitting the irregularities on the road surface to the steering wheel.

The lower and upper arm levels now move simultaneously in response to wheel deflection. As a result, as the spring compresses, the wheel pivots in such a way that the camber does not decrease as much as is the case with a spring strut front axle.

Since the two control arm levels undertake the wheel control, the damper is virtually no longer subjected to transverse forces and rotational motion.

This makes it possible to do without a roller bearing assembly on the spring strut support. Instead of this conventional roller bearing, a damping and support unit is installed that takes up all three load paths. The load paths are the damper piston rod, the inner auxiliary spring and the bearing spring. This damping and support unit is still referred to as the "strut mount".

Due to the lack of transverse forces, the piston rod can be made thinner, resulting in a similar displacement volume in the push and pull direction of the damper. This serves to improve the design layout of the damper and is the prerequisite for the innovative damper control system - vertical dynamics control (VDC).

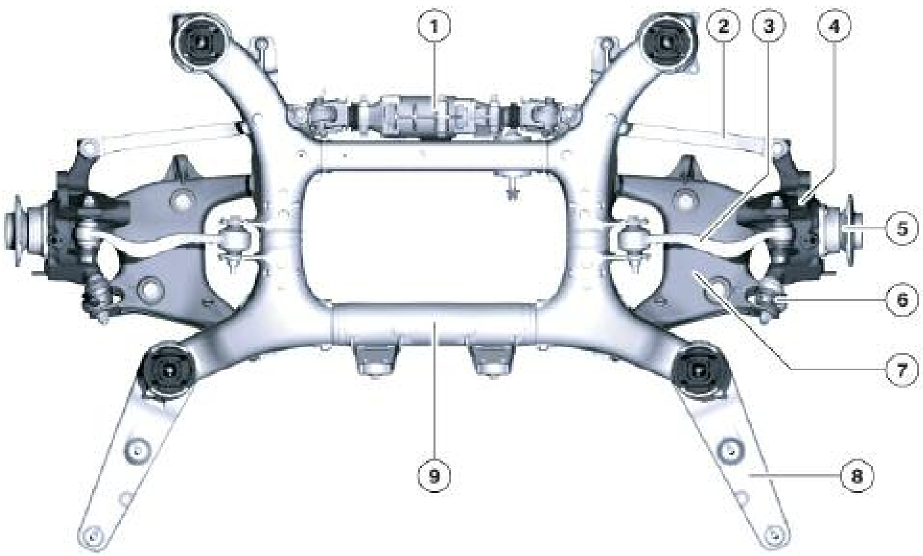
Due to the substantially lower friction at the circumference of the piston rod, the damper can respond more sensitively.

By connecting the stabilizer bar via the stabilizer link to the spring strut, the torsion in response to body roll motion is equivalent to the total wheel lift from the inside to the outside of the curve (in other suspension setups, the stabilizer bars are connected to a transverse control arm and therefore achieve only a fraction of the torsion angle).

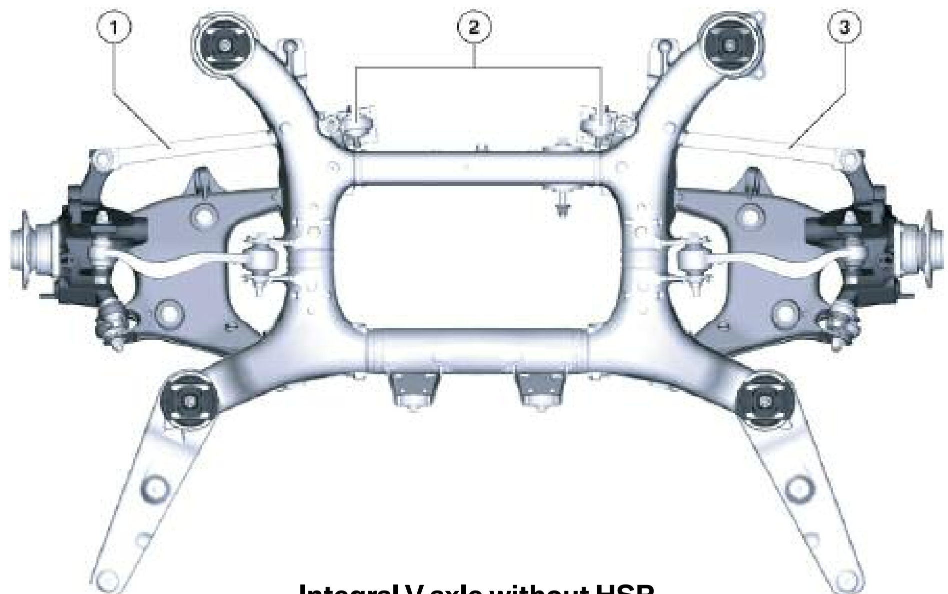
Despite being highly effective, this high degree of torsion allows for the stabilizer bar to be made relatively thin which has a favorable effect on driving comfort and dynamics as well as saving weight.

New Rear Axle

The rear axle design on the F01/02 is a newly designed axle known as the "integral-V". This differs from the previous 7 Series which used the familiar and already proven "integral IV". The integral IV rear axle design was introduced on the E38 in 1995 and has been in use on subsequent 5, 6 and 7 series models as well as both generations of the X5.



Integral V axle with HSR



Integral V axle without HSR

Index	Explanation	Index	Explanation
1	Actuator, rear axle slip (thrust) angle control (HSR)	6	Integral link
2	Track rod, left	7	A-arm (swinging arm)
3	Transverse control unit, top	8	Thrust strut
4	Wheel carrier	9	Rear axle carrier
5	Wheel bearing		

Index	Explanation	Index	Explanation
1	Track rod, left	3	Track rod, right
2	Bearing assemblies, track rod		

Now, there are new challenges to meet with regard to rear axle design. While the integral IV axle met and exceeded all of the requirements of BMW chassis dynamics, the integral V was developed to meet some of the new requirements of the F01/02 including:

- Larger vehicle dimensions
- Greater total weight
- Greater drive output
- Higher drive torque
- Run flat tires (RSC)

In addition, the demanding objectives relating to driving dynamics and comfort have been correspondingly adapted while the new system integrates driving dynamics systems required for this purpose.

An additional design requirement of the new rear axle is the ability to allow changes in the thrust (slip) angle. This accommodation allows for a small degree of movement to execute slight steering movements. This is part of the new Integral Active Steering System which includes HSR.

The Integral IV axle from the E65 is capable of executing rear steering movement, but the design of the axle would require a much larger actuator. Therefore, the Integral V axle was introduced to meet these needs.

There are two axle designs for the F01/F02. One is the standard rear axle (w/o HSR), the other has the actuator for the HSR which includes modified track rods.

Rear Axle Data

Description (Rear axle data)	F01 (Standard)	F01 (optional HSR)
Wheel base (mm)	3070	3070
Track width	1628	**1650**
Camber	-1° 50' ±15’	-1° 50' ±15’
Camber difference	0° ±30'	0° ±30'
Total toe-in	14' ±10’	16' ± 6'
Thrust angle	0° ±12'	0° ±12'

Rear Axle Alignment Procedures

Due to the design of the Integral V rear axle, the alignment procedure differs from previous models. When performing a rear axle alignment on all models previous to the F01, rear Camber is always adjusted before rear Toe. This has been the common practice up to this point.

The new rear axle geometry on the F01 is such that any adjustments to the Camber or Toe eccentrics will influence both adjustments. Therefore, it is necessary that Camber is the last adjustment rather than Toe.

Refer to the latest repair instructions in Group 32 under “Steering and Alignment” under “Adjust Rear Axle”.

Workshop Exercise - Vehicle Alignment

Model: F01/F02

Production: From Start of Production

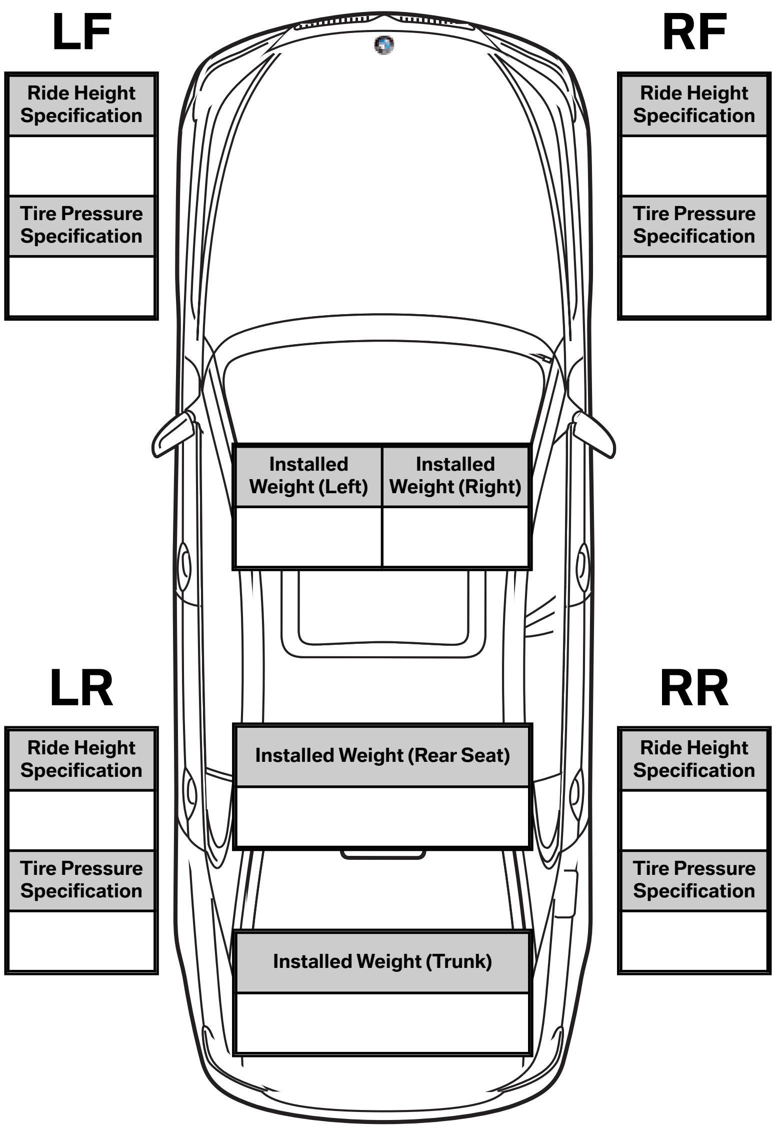
OBJECTIVES

After completion of this module you will be able to:

- To learn how to plot rear suspension adjustments using the appropriate graph.
- Align rear suspension using plotted adjustment points.
- Learn the correct procedures required when aligning a vehicle with Integrated Active Steering.
- How to perform a front camber adjustment on a F01/F02.

Workshop Exercise - F01/F02 Vehicle Alignment

Using the designated vehicle perform a four wheel alignment following the steps outlined in the following exercise. Connect ICOM to vehicle and perform vehicle test. Locate wheel alignment and ride height specifications using ISID.



Note: Remove turnlate pins and thoroughly settle suspension prior to ride height measurement.

If vehicle is equipped with EHC adjust rear axle ride height if required.

What should be done prior to performing a wheel alignment on a vehicle with EHC?

____

Is the vehicle equipped with HSR? **YES** or **NO**

If so execute the test plan to be sure the rear steering actuator is centered.

When executing the rear steering test plan what value must be achieved before adjusting the rear suspension?

______ o

Install wheel adapters and targets and begin wheel alignment.

Important!!! **Suspension must be thoroughly jounced prior to taking any alignment readings.**

Workshop Exercise - F01/F02 Vehicle Alignment

Do either of the rear wheels need to be adjusted? If so plot the adjustments on the graph provided.

Left Rear:
Where does the plotted point intersect line D?

Left Rear Camber ___________' (Conversion - ______ °_____')

Left Rear Toe ____________'

Perform intermediate adjustment using the "control arm eccentric" (upper link). The camber and toe should now match your plotted points from the answers above!

Identify the rear camber and toe specs from graph.

Left Rear Camber (spec) _______ ' (Conversion - ______ °_____')

Left Rear Toe (spec) ______ '

Perform final adjustment using the "swing arm eccentric" to bring camber and toe where line C & D intersect on graph.

Right Rear:
Where does the plotted point intersect line D?

Right Rear Camber ___________' (Conversion - ______ °_____')

Right Rear Toe ____________'

Perform intermediate adjustment using the "control arm eccentric" (upper link). The camber and toe should now match your plotted points from the answers above!

Identify the rear camber and toe specs from graph.

Right Rear Camber (spec) _______ ' (Conversion - ______ °_____')

Right Rear Toe (spec) ______ '

Perform final adjustment using the "swing arm eccentric" to bring camber and toe where line C & D intersect on graph.

What is the torque specification for the control arm (upper) nut?

_______________ **Nm**

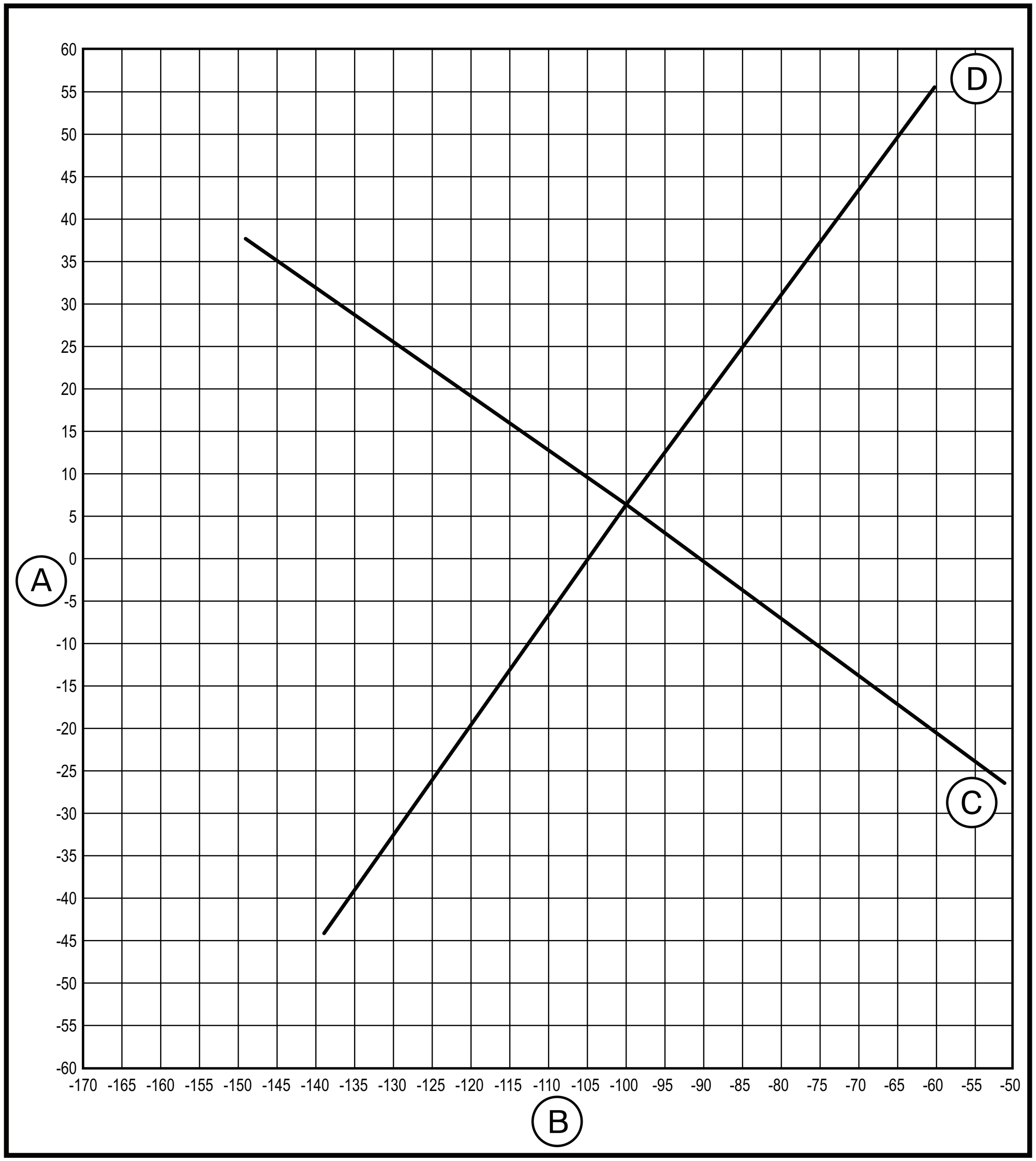
What is the torque specification for the swing arm (lower) nut?

_______________ **Nm**

Should the eccentric nuts be replaced? **YES** or **NO**

Important!!! **After adjusting the second wheel on the rear axle be sure that the first wheel is still in specs. It may be necessary to readjust first wheel after setting the second wheel if the vehicle was severely out of specifications. If a second adjustment is required the points must be plotted.**

Chart for Adjusting F01/F02 Rear Axle

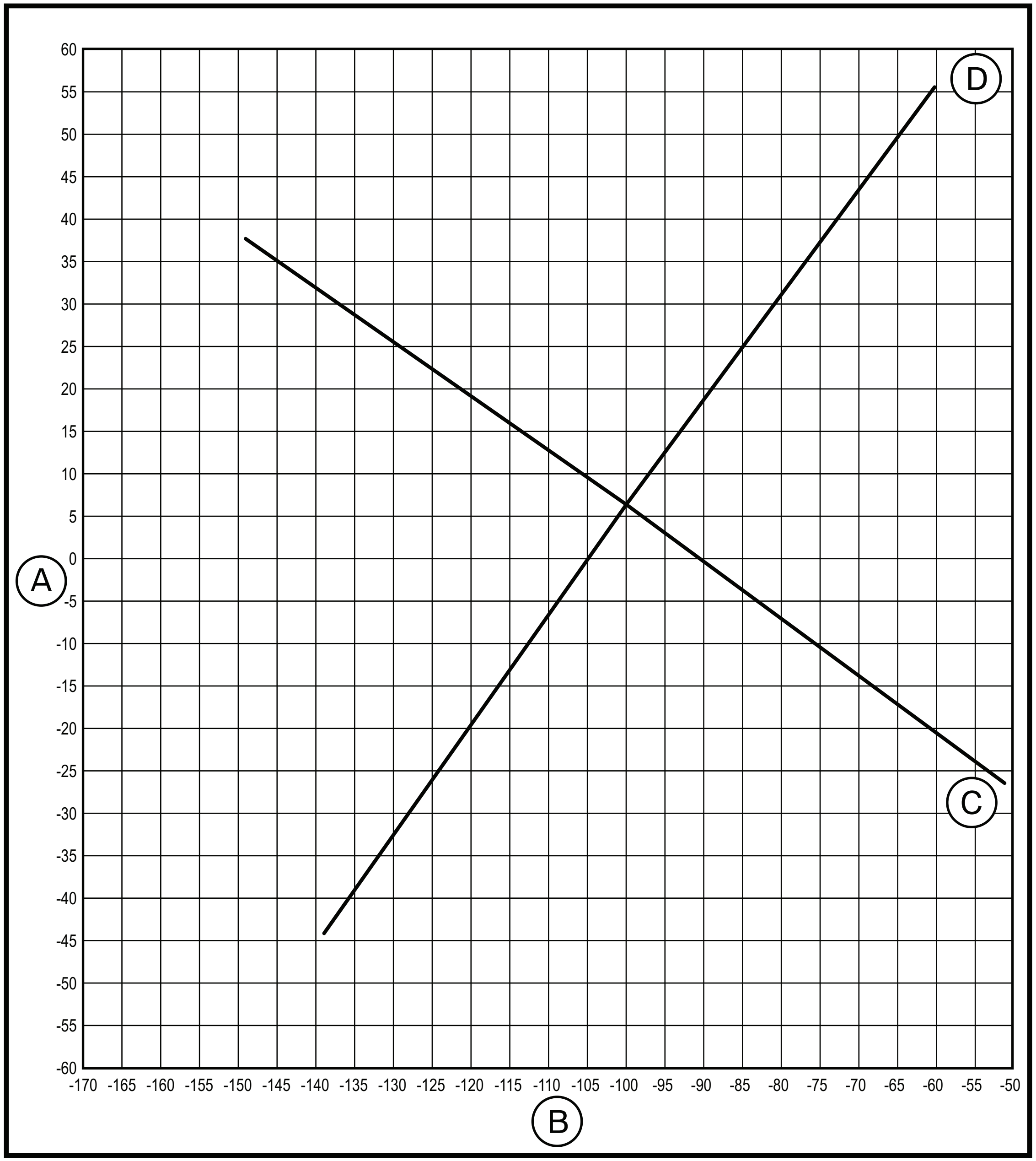


Left Rear Wheel

Key:
Unit of measurement in diagram: [min]

A	Toe
B	Camber
C	Control Arm
D	Swinging Arm

Chart for Adjusting F01/F02 Rear Axle



Right Rear Wheel

Key:
Unit of measurement in diagram: [min]

A	Toe
B	Camber
C	Control Arm
D	Swinging Arm

Workshop Exercise - F01/F02 Vehicle Alignment

How is the front camber adjustment performed? Are there any special tools needed to perform camber adjustment? If so please list and explain. ______________________________

____

____

What other BMW vehicles use this method of front camber adjustment? ______________________________

____

Note: Adjust front camber as required!

Note: If vehicle is equipped with Active Front Steering then execute the Initialization/Adjustment Procedure!

List at least three conditions that will require Active Front Steering initialization. ______________________________

____

Important!!! **Install Steering Wheel Level at this time to insure accuracy and center steering.**

When asked in the Test Plan "Is there a customer complaint about steering wheel askew"? Answer: ***YES***

Your Instructor will demonstrate when to answer "NO" later.

Continue in test plan. Did AL warning lamp illuminate? **YES** or **NO**

Continue to follow procedure exactly as described.

Was the procedure completed successfully and did the AL warning lamp go out? **YES** or **NO**

This procedure must be completed successfully in order to continue with front toe adjustment. Repeat if necessary.

When asked if a wheel alignment is necessary? Answer: ***YES***

What is the tolerance for the virtual steering angle sensor?

____

____

Important!!! **This value must be maintained during front toe adjustment!**

Front Toe (BEFORE ADJUSTMENT)

LEFT ______________ ' RIGHT ______________ '

Front Toe (AFTER)

LEFT ______________ ' RIGHT ______________ '

After completing the front toe adjustment is the AL warning lamp on? **YES** or **NO**

If "NO" was answered then no further initialization is required. Vehicle should be road tested to insure proper center steering.

What are some other systems on the F01 that might require calibration after a wheel alignment?

____

____

____

Damping and Suspension

The F01/F02 is equipped as standard with the latest variation of vertical dynamics control (VDC 2) featuring electronically controlled damper systems.

The standard chassis and suspension system of the F01 features steel springs on the front and rear axle. The standard chassis and suspension on the F02 has steel springs on the front axle with the “single axle” air suspension (EHC) fitted on the rear axle.

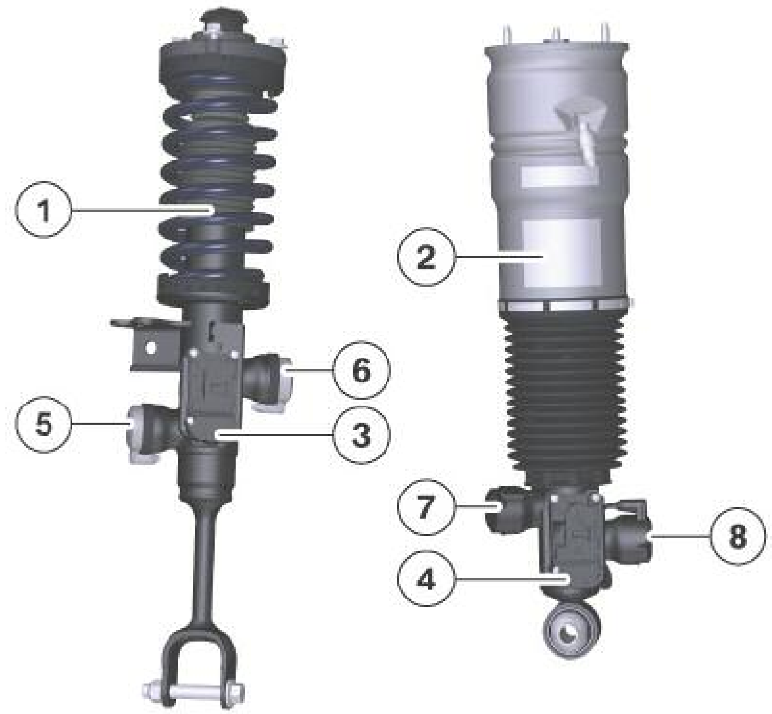
In addition, the following combinations are available:

- Standard suspension with “single axle” air spring (on rear)
- Dynamic drive (ARS) with steel springs and VDC dampers
- Dynamic drive (ARS) with 2 steel springs and single axle air spring and VDC dampers.

BMW is the first car maker to offer a standard, continuously controlled adjusting damper system which has different properties regarding the tension/compression phases.

The outstanding properties of this new (VDC2) adjusting damper are:

- Advanced opening adjustment for improved body stabilization. Realized by adjustments even at low damper speeds.
- Difference between "soft" and "hard" in connection with driving dynamics control easily identifiable by the customer.
- The 2 EDC data-map valves (per damper) allow for different characteristics between compression and extension phases (jounce and rebound).



Index	Explanation
1	VDC damper (front) with steel spring
2	VDC damper (rear) with air spring
3	Front EDC satellite control unit
4	Rear EDC satellite control unit
5	EDC data-map valve for compression control
6	EDC data-map valve for extension control
7	EDC data-map valve for extension control
8	EDC data-map valve for compression control

Brakes

Function-optimized lightweight construction brakes are used on the F01/F02. Lightweight brake discs with riveted aluminum hub are installed on the front axle. The rear axle brakes consist of a conventional, cast iron brake rotor.

Floating brake calipers are fitted on the front and rear axle. However, the front calipers are lightweight aluminum, while the rear are cast iron.

The brake system in the F01/F02 features the known brake wear monitoring system for the CBS indicator.

Technical Data, front brakes

Technical data, front brakes	Specification
Brake caliper, piston diameter (mm)	60
Brake disc, thickness (mm)	36
Brake disc diameter (mm)	373
Brake disc diameter (inches)	14.7
Brake disc construction	Aluminum (riveted)
Brake caliper construction	Aluminum

Technical Data, rear brakes

Technical data, rear brakes	Specification
Brake caliper, piston diameter (mm)	44
Brake disc, thickness (mm)	24
Brake disc diameter (mm)	368
Brake disc diameter (inches)	14.5
Brake disc construction	Cast iron
Brake caliper construction	Cast iron

Tires and Wheels

Unlike the E65 predecessor, the F01/F02 is fitted with the Run Flat System Component (RSC) package on board as standard.

The BMW Group has put together a safety package with the aim of avoiding such accidents as well as the risk involved with changing a tire at the side of the road, at night or in wet conditions, in tunnels or at road construction sites.

The BMW runflat safety system:

- Warns the driver in good time of imminent tire pressure loss so that countermeasures can be taken
- Allows the journey to be continued for a defined distance even in the event of complete loss of tire pressure
- Keeps the tire safely on the rim even in the event of sudden tire pressure loss at high speed.

The system consisting of the RSC tires, rims with EH2+ contour and the electronic tire pressure monitoring system (TPMS).

With its reinforced side walls, additional strip inserts and heat-resistant rubber mixtures, even when completely depressurized, the "self-supporting tire" makes it possible to continue the journey for a limited distance at a maximum speed of 50 mph.

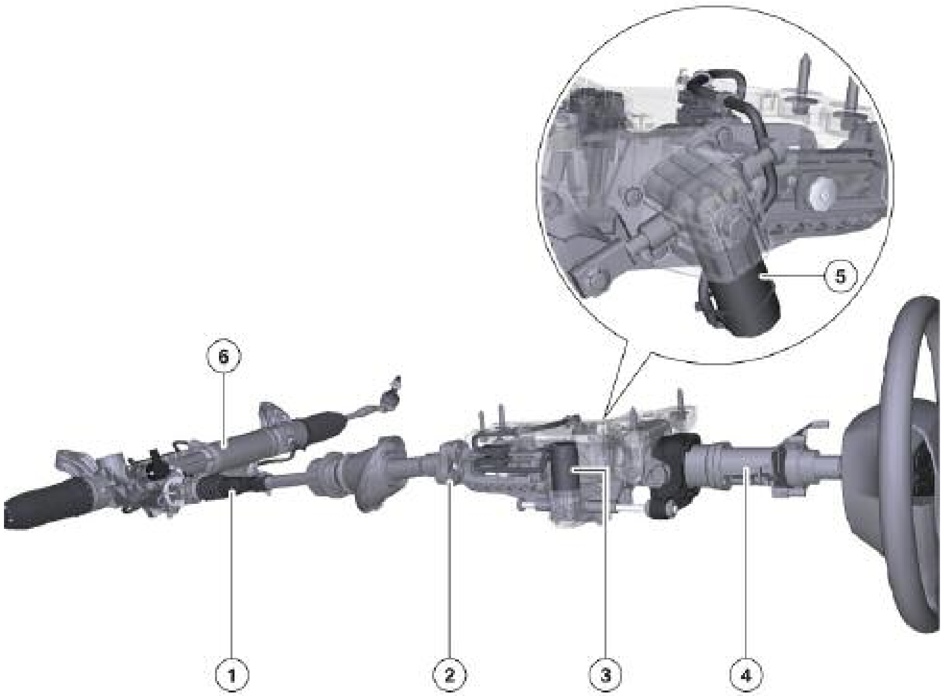
Refer to the owners manual for the maximum driving range after puncture or deflation occurs.

ABS, ASC and DSC remain fully operational even in the event of complete tire pressure loss.

When driving with a run flat tire with no pressure, the standard VDC automatically distributes the vehicle weight over the remaining wheels so as to relieve the load on the depressurized tire with the aim of achieving the highest possible range for continued operation.

Steering

The steering column in the F01/F02 is designed to conform with the most demanding requirements in terms of ergonomics, comfort and passive occupant safety all coupled with characteristic BMW steering properties.



Index	Explanation	Index	Explanation
1	Splined tube	4	Crash tube
2	Flexible coupling	5	Actuator motor, right
3	Actuator motor, left	6	Steering gear

The F01/F02 is equipped with an electrically operated steering column with infinitely variable horizontal and vertical adjustment as standard.

- Outstanding ergonomics ensured by an optimum adjustment range for the steering wheel position:

  – Horizontal ± 30 mm

  – Vertical ± 20 mm

- Additional comfort function provided by easy entry and exit:

  – When getting in and out of the vehicle, the steering wheel temporarily moves into the topmost position thus providing maximum freedom of movement.

- Outstanding crash safety provided by the familiar, innovative BMW crash system, specifically tuned and featuring force dependent energy absorbers.

The steering column has a motor for in/out adjustment and a motor for up/down adjustment with a specially developed gear mechanism.

Each of these low-noise drive units is mounted acoustically decou-pled executes the adjustment with the aid of motor/driven flexible spindles.

The components of the steering column are optimized in terms of rigidity in the comfort relevant frequency range to reduce vibration and avoid disturbing steering wheel vibration and have been developed in line with a magnesium and aluminum lightweight construction concept.

The flexible coupling fitted in the steering column represents the perfect means of finely tuning the steering characteristics and driving comfort. Vehicle-specific coupling packages are vulcanized in elastomer in this flexible coupling, allowing extremely high torque to be transmitter reliably and precisely.

The steering column is thus successfully decoupled from disturbing influences caused by excitation from the road surface (axial impact or radial torque peaks).

The innovative crash system essentially consists of a crash adapter and crash tube. In the event of a crash, the impact energy is progressively reduced for the driver by the crash tube breaking open and deforming, thus providing the advantage of reduced stress on the occupants in the event of a crash (integral part of the 5-star philosophy at BMW).

Index	Explanation	Index	Explanation
1	Normal position (0 mm)	2	Crash position (travel 80 mm)

In addition, the lower and center steering shaft collapses during the crash thus preventing penetration of the steering column into the passenger compartment. The system design also prevents the back displacement of all components in the engine compartment and possible damage to the bulkhead.

Classroom Exercise - Review Questions F01 Chassis and Suspension

1. What type of rear axle is used on the F01? (circle one)

   HA V **Integral IV**

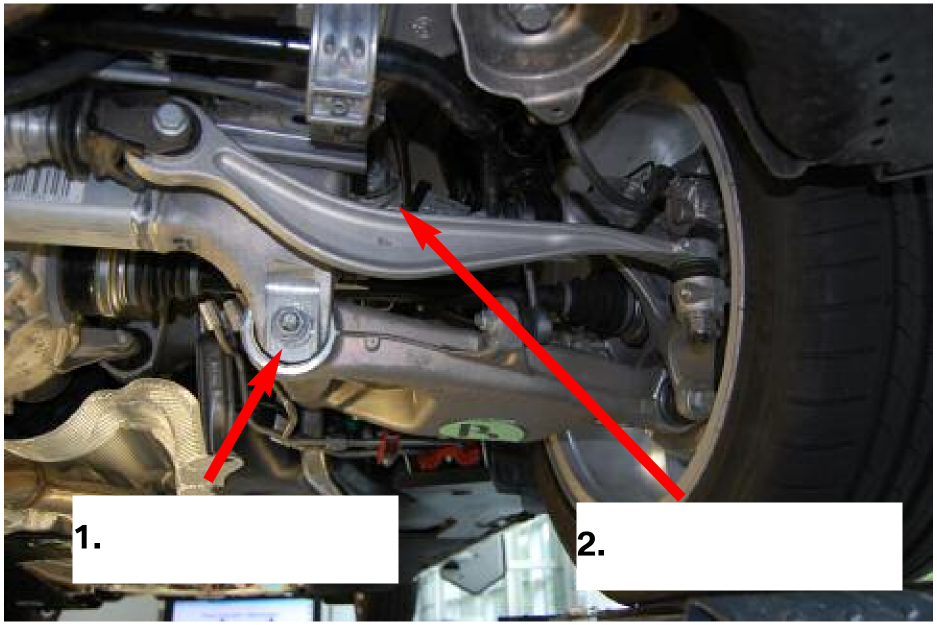
   Integral V **Central-link**

2. What is different about the tires used on the F01? (as compared to the E65)

3. How is front Camber changed on the F01/02?

4. What is different about the dampers (struts) on the F01?

5. What must be considered when making adjustments to the rear axle on the F01/F02?



6. Label the above adjustment points for th Integral V axle on the F01/F02.

7. List some of the benefits of the “double wishbone” front suspension:

Classroom Exercise - F01/F02 Comparison of Standard/Optional Systems

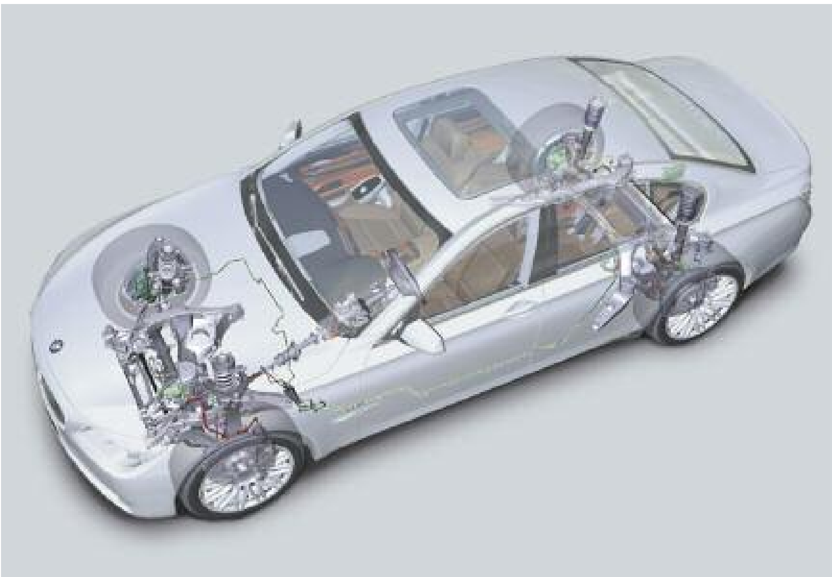
With instructor assistance, work through the chart below.
Fill in the optional/standard chassis systems on the F01 in comparison to the E65.

Dynamic Driving System	E65/E66		F01/F02	
	Standard	**Optional**	**Standard**	**Optional**
Higher Level Driving Dynamics Systems				
Integrated Chassis Management				
Driving Dynamics Control				
Longitudinal Dynamics				
Dynamic Stability Control				
Electro-Mechanical Parking Brake (EMF)				
Lateral Dynamics				
Servotronic				
Integrated Active Steering (IAL)				
Vertical Dynamics				
Electronic Damping Control (continuous) EDC-K				
Vertical Dynamics Control 2 (VDC 2)				
Active Roll Stabilization				
Electronic Height Control				
Driver Assistance				
Cruise Control (FGR)				
Cruise Control with braking function (DCC)				
Active Cruise Control (ACC)				
Active Cruise Control with Stop and Go (ACC Stop and Go)				

Dynamic Driving Systems

History of Dynamic Driving Systems

Since the introduction of the previous 7 Series, the E65, there have been many developments in the area of dynamic driving systems on all BMW models.



Now, with the introduction of the F01, these past developments are now combined with the latest innovations to make for a truly "Dynamic" driving experience.

For example, the introduction of the longitudinal dynamics management system in the BMW 3 Series (E9x) was the first step in this direction. The longitudinal dynamics control functions, Dynamic Cruise Control and Active Cruise Control, were integrated into one control unit - the LDM control unit. These integrated functions considerably enhanced the harmony and coordination of drive and brake actuation.

The Vertical Dynamics Management made its debut in the BMW X5 (E70) with the VDM control unit: the integrated Vertical Dynamics Control (VDC) function controls the adjustable dampers.

In contrast to the earlier system, not only ride-level heights and vertical acceleration are used as the input signals. Instead, the higher-level control strategy of the Vertical Dynamics Control takes all signals relevant to driving dynamics into account including, for example, road speed, and longitudinal/lateral acceleration.

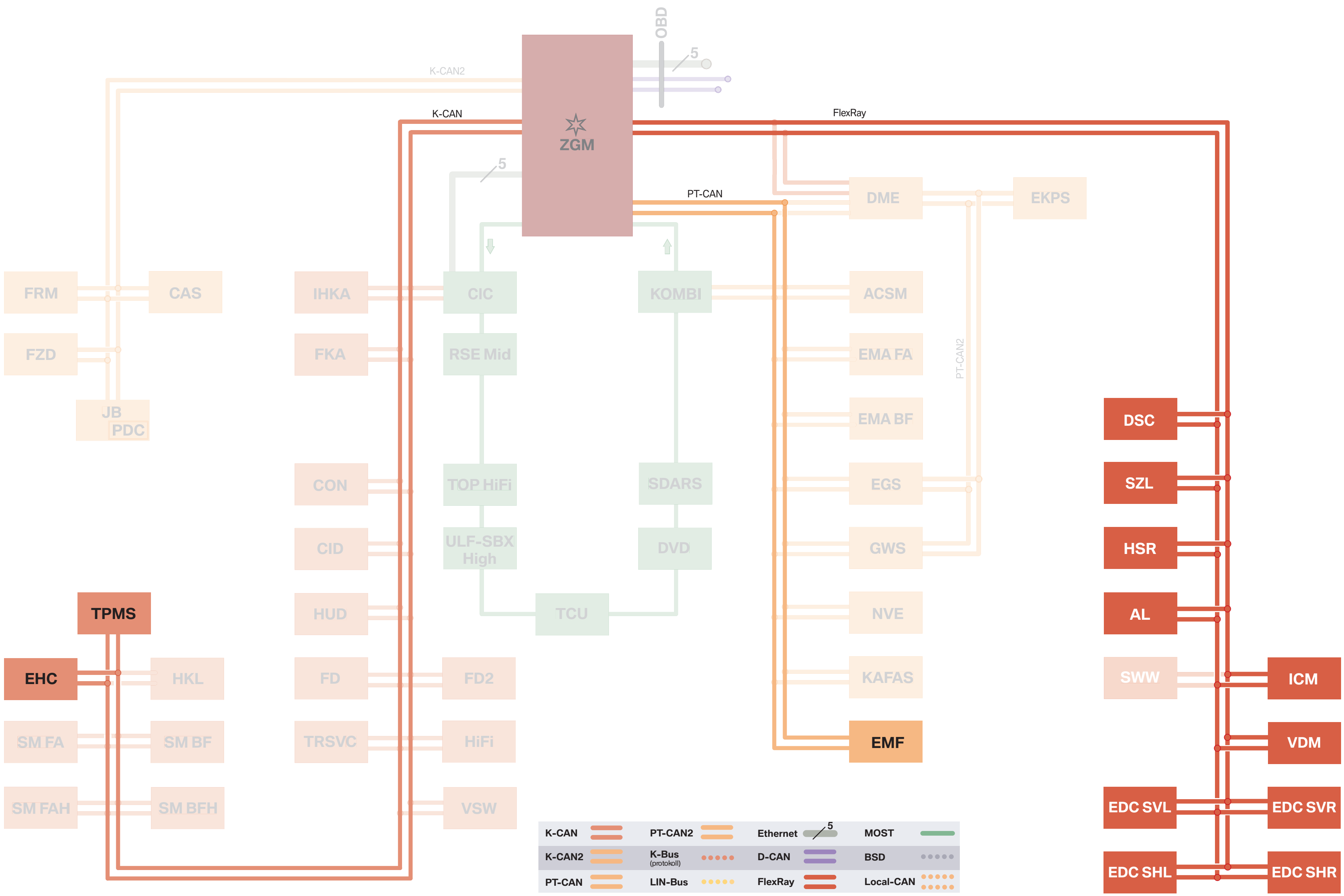
The VDM control unit also coordinates the Vertical Dynamic Control and Active Roll Stabilization (ARS) functions. Overall, this meant that wheel contact with the road surface was improved and the vertical movement of the body reduced for a wider variety of road situations.

In addition to the VDM control unit, the BMW X6 (E71) was also equipped with an ICM control unit that for the first time incorporates both the longitudinal and lateral dynamics control functions.

The longitudinal and lateral motion of the vehicle is evaluated centrally in the ICM control unit. Following on from this development, the dynamic driving systems Active Steering and Dynamic Performance Control are now used and their interaction is of course also coordinated by the ICM control unit.

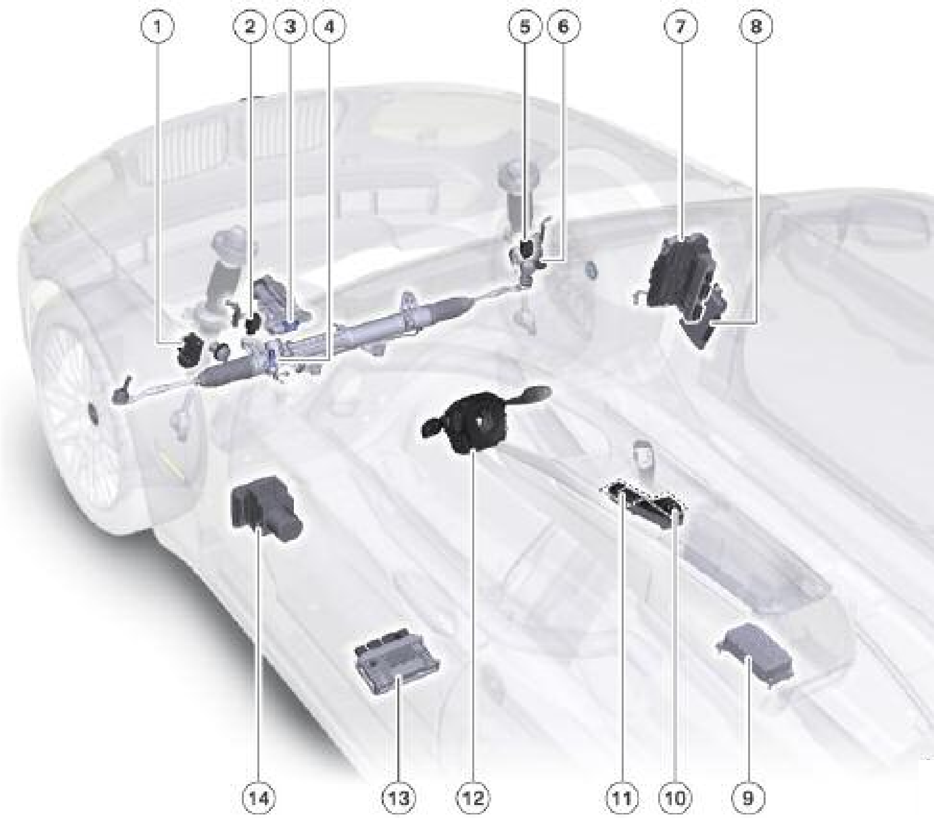
Significant at this stage is the definition of the ICM as the main control unit for the control functions. The actuators on the other hand are activated by control units specially intended for this purpose.

Bus System Overview for Dynamic Driving Systems



Workshop Exercise - Component Location - Integrated Chassis Management

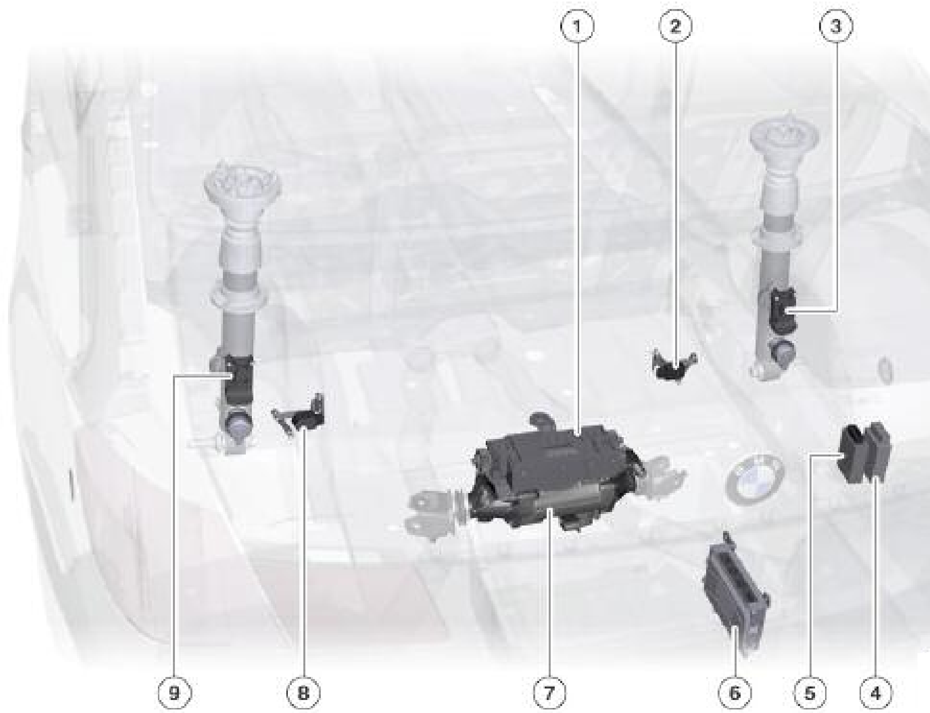
On an F01/F02, locate the components on the vehicle, then fill in the chart by using the supplied bus charts and wiring diagrams in ISTA to determine the electrical connections to the vehicle network (refer to example).



Index	Explanation	Connected to	by way of
1	EDC, SVL		
2	Ride height sensor, FL		
3	EVV Valve		
4	Servotronic valve		
5	Ride height sensor, FR		
6	EDC, SVR		
7	JB electronics		
8	VDM		
9	ICM		
10 a	EMF buttons		
10 b	Auto-Hold button		
11	Driving Dynamics switch/DTC button		
12	SZL/LWS		
13	AL (AS)		
14	DSC		

Workshop Exercise - Component Location - Integrated Chassis Management

On an F01/F02, locate the components on the vehicle, then fill in the chart by using the supplied bus charts and wiring diagrams in ISTA to determine the electrical connections to the vehicle network (refer to example).

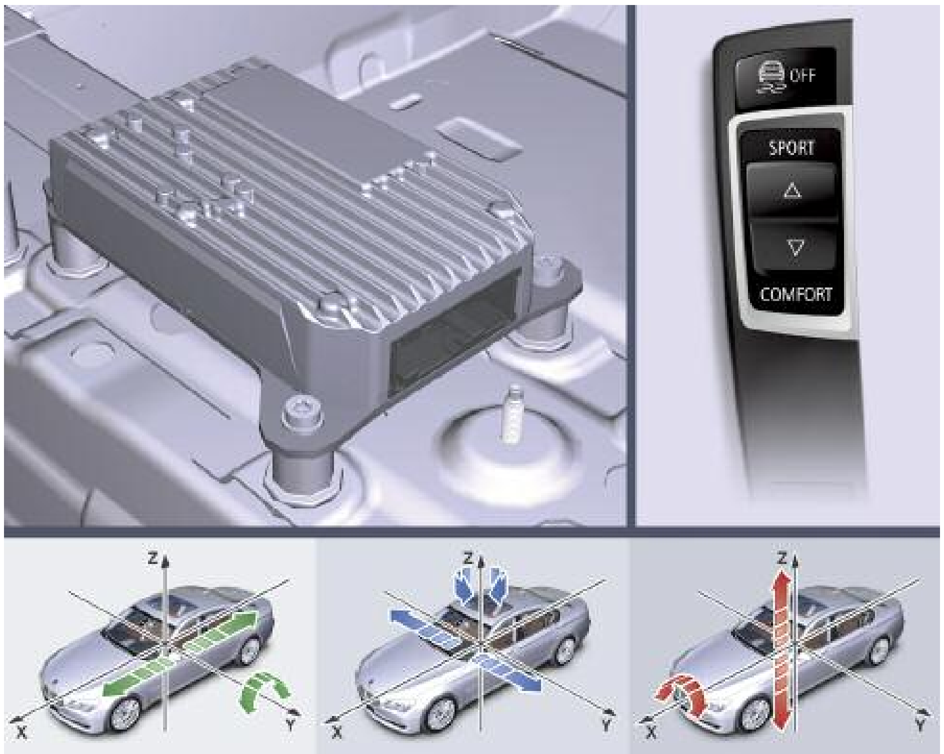


Index	Explanation	Connected to	by way of
1	EMF Control module and actuating unit		
2	Ride height sensor, right rear		
3	EDC, SHR		
4	TPMS Control module		
5	EHC Control module		
6	HSR control module		
7	HSR actuator		
8	Ride height sensor, rear left		
9	EDC, SHL		

Changes to Driving Dynamics Control

In the F01/02, the management of chassis systems has been further developed to improve the performance and interaction of the individual dynamic driving systems.

The integration of the ICM module into the new 7 series allows the desired dynamic effect in each road situation. Also, the most suitable actuator can now be selected and activated.



For example, in some instances it might be necessary to activate the brakes for individual wheels (DSC) while superimposing a steering angle using the Integral Active Steering (IAL).

A further task of the ICM control unit is to make the driving dynamics condition available throughout the entire vehicle through in the form of signals. This is why the DSC sensor in the F01/F02, which was previously fitted separately, has now been integrated into the ICM control unit.

This means that all systems have access to the same information provided by the ICM control unit. As a consequence, the potential for errors, particularly in networked systems, is reduced and the system reliability of systems is increased.

Further, this simplifies the diagnosis of the interconnected system as the fault code memory entries for the driving dynamics signals are now stored centrally in the ICM control unit and are no longer distributed between many control units.

The result for the customer is perfect harmony in terms of vehicle handling - irrespective of the equipment specification and road situation. This uses the possibilities for maximizing convenience, agility and stability to the fullest.

The customer's experience of this harmony in terms of vehicle handling is especially enhanced by the new **Driving Dynamics Control** function.

This offers several particularly distinctive vehicle characteristics that determine how the vehicle handling as a whole is perceived by the driver and passengers.

The driver can use the driving dynamics switch to select a characteristic that perfectly matches the specific driving requirement or section of road.

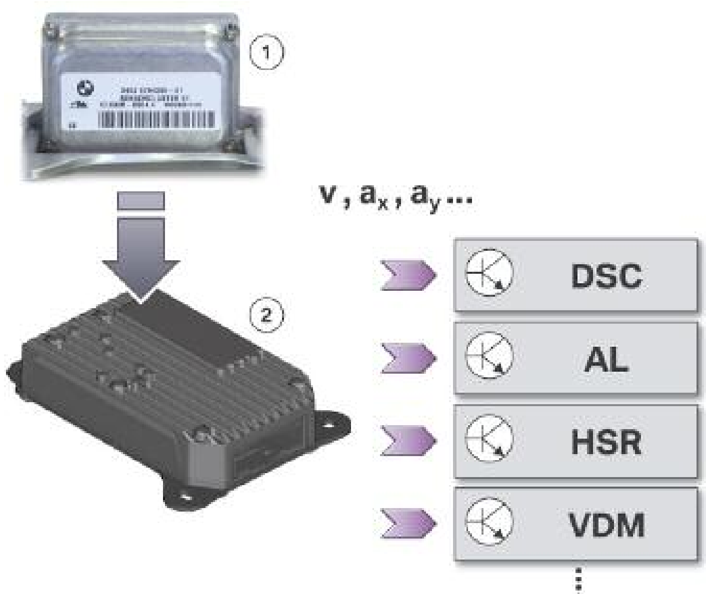
New Control Units

Two newly developed control units for dynamic driving systems will also be used in the F01/F02:

- Integrated Chassis Management (ICM) and
- Vertical Dynamics Management (VDM).

Although their names are already familiar from the E70/E71, they differ considerably in their functional range and design. A multitude of driving dynamics functions is concentrated in these control units.

Driving dynamics signals provided by the ICM



Index	Explanation	Index	Explanation
1	DSC sensor integrated into the ICM	DSC	Dynamic Stability Control
2	ICM control unit	AL	Active Steering
v	Road speed	HSR	Rear axle slip angle control
a_x	Longitudinal acceleration	VDM	Vertical Dynamics Management
a_y	Lateral acceleration		

In addition to central signal provision, the essential functions of the ICM control unit are concerned with longitudinal and lateral dynamics. These include the control function for the new Integral Active Steering, for example.

The vertical dynamics functions on the other hand are incorporated in the VDM control unit. These include:

- Vertical Dynamics Control 2 (2nd generation)
- Active Roll Stabilization (ARS a.k.a Dynamic Drive).

Although both control units are standard equipment, two expansion stages are available in each case, depending on the options fitted to the vehicle.

Expansion stages of ICM control unit

The basic version of the ICM control unit is fitted as standard in the F01/F02. In this case, the vehicle is provided with the Servotronic steering system and cruise control driver assistance function with braking function (DCC).

The high-performance version of the ICM control unit is used if one or both of the following options are ordered by the customer:

- Integral Active Steering
- Active Cruise Control with Stop & Go function

Expansion stages of VDM control unit

The basic version of the VDM control unit contains the Vertical Dynamics Control function. This is included in the standard equipment of the F01/F02.

The high-performance version of the VDM control unit is fitted if the customer also orders the optional ARS. The high-performance version also incorporates the output stages required for activation of the hydraulic valves in the ARS.

ICM Control Unit

An ICM control unit is installed in every F01/F02. Each ICM control unit contains the following, irrespective of the equipment installed in the vehicle:

- Two microprocessors
- A FlexRay controller
- Output stages for activating valves in the steering system
- Integrated sensor system for driving dynamics variables (previously: DSC sensor).

The essential tasks of one of the microprocessors are the calculation of control functions, communication processing and activation of the output stages.

The main task of the second processor is to monitor safety relevant functions and bring about a system shut down in the event of a fault.

The other components of the ICM control unit listed above are described in the following chapters.

Two versions of the ICM control unit exist. The version installed in the vehicle depends on the equipment.

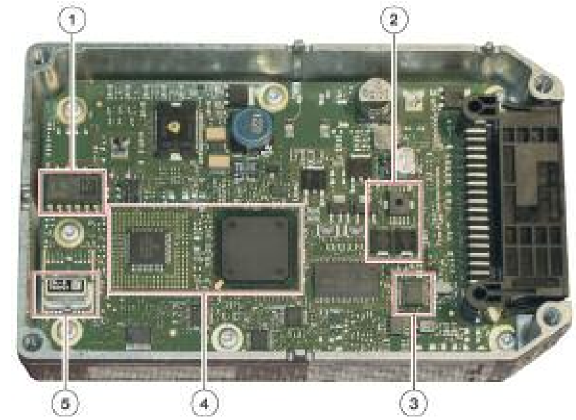
The internal layout of the high-performance version differs from the internal layout of the basic version in the following ways:

- Larger microprocessor (required to calculate the Integral Active Steering control and active speed control)
- Redundant sensor system for lateral acceleration and yaw rate (safety requirement for Integral Active Steering).

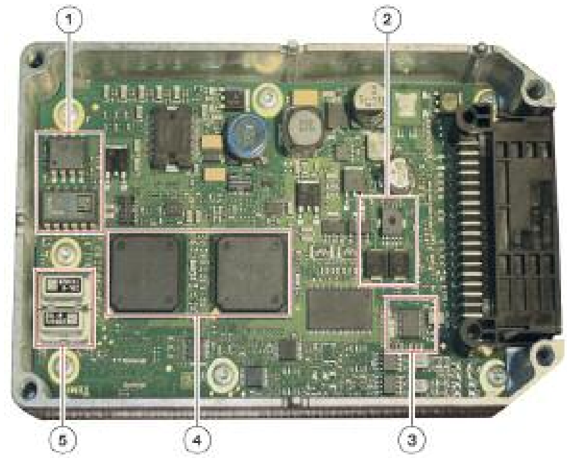
The sensors that were previously accommodated in the DSC sensor are now housed in the ICM. Therefore there are no independent DSC sensors on the F01.

The following graphics make these differences clear.

ICM Control Module, basic version



ICM Control Module, high performance version

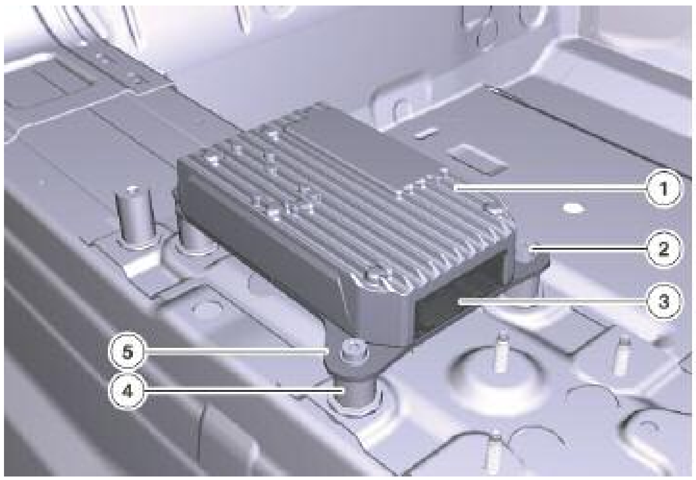


Index	Explanation
1	Acceleration sensor (longitudinal and lateral acceleration)
2	Output stages for Servotronic and EVV valves
3	Controller for FlexRay connection
4	Two microprocessors
5	Yaw rate sensor (2 for HP version)

Location and Mounting of the ICM Module

The ICM control unit is installed in the center console behind the central sensor for the ACSM. This means that the position of the control unit and its integrated sensor system in the vehicle, near to its center of gravity, is ideal from the point of view of driving dynamics.

The mounting points on the body are precisely determined and are measured when the vehicle is manufactured and must not be replaced with any other mounting points.



Index	Explanation	Index	Explanation
1	Upper section of housing	4	Spacer sleeve
2	Mounting bolt	5	Lower section of housing
3	Connector		

The housing of the control unit is connected to the metal body of the transmission tunnel with four screws and spacer sleeves made of aluminum. The control unit must be mounted on the vehicle body free of play as otherwise vibrations may be induced in the control unit housing which would severely impair the operation of the integrated sensor system.

A secondary task of this mounting is to conduct heat away from the control unit to the body.

For the mounting to be able to perform these tasks, the following points must be observed when mounting and replacing the ICM control unit:

- Use only the correct spacer sleeves and mounting bolts.
- The mounting bolts must be tightened in the correct order (See repair instructions)
- The tightening torque specified in the repair instructions must be observed without fail.
- A check must then be carried out to make sure the control unit is mounted securely and free of play.
- To ensure sufficient heat dissipation and to avoid vibrations, the sides and top of the control unit housing must not come into contact with other vehicle components.
- In the center console, where the ICM is located, the provided “air space” must be maintained. Harnesses and cables should be routed correctly and must not contact the ICM.
- Aftermarket accessories should not be in the vicinity of the ICM.
- The wiring harness that runs in the center console in particular must never be routed in, or even pushed into, the spaces on either side of the ICM control unit.

Ride-height Sensors

Design and Principle of Operation

The angle of a pivoting arm is converted to a voltage signal via the ride-height sensors. The greater the angle (with reference to a defined starting position), the greater the output voltage generated by a Hall sensor element.

Versions

Four ride-height sensors are installed in every F01/F02. However, the ride-height sensors installed in the vehicle are in different versions. Different ride-height sensors are used on the left and right of the front axle.

Different ride-height sensors are also used on the rear axle.

The reasons for this in both cases are the available installation space and the starting position of the pivoting arm.

Double or single-type ride-height sensors are used at the rear axle, depending on whether the vehicle is equipped with electronic ride height control (EHC). Single-type ride-height sensors are always used at the front axle.

Interface with ICM Control Unit

Each ride-height sensor (irrespective of the version) is connected to the ICM control unit by three wires. The double-type ride-height sensors at the rear axle are also connected to the EHC control unit according to the same principle via three additional lines.

Power is supplied by the ICM control unit to the ride-height sensor via one of the lines. The sensor uses the second line to deliver its measurement signal (0-5 V DC voltage). The third line is connected to a common earth inside the ICM control unit.

The measurement signal is evaluated by means of voltage measurement in the ICM control unit. The ICM control unit cannot calculate the actual ride-level heights in millimeters on the basis of this information alone.

To perform this calculation, the ICM control unit must be able to map the voltage signals it receives to reference values. This is the only way to establish a relationship between the measurement signals and the actual ride-level heights.

These reference values are determined during a synchronization procedure.

The ride-height signals in the ICM must be synchronized in the following cases:

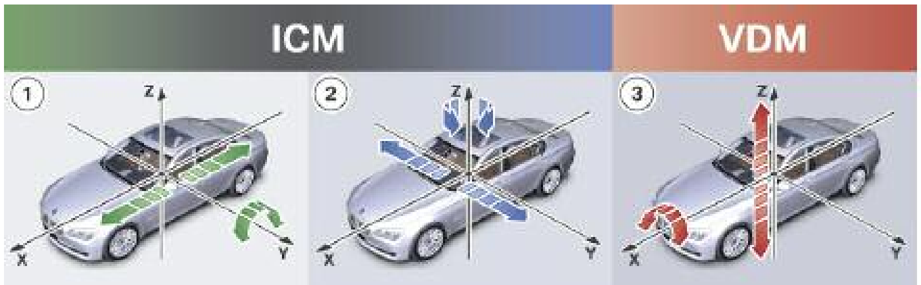
- following replacement of the ICM control unit,
- following replacement of a ride-height sensor or
- if prompted to do so by the test schedule of the diagnostic system (due to a fault code memory entry in the ICM).

The synchronization does not have to be carried out if a wheel has been changed.

NOTES PAGE

Integrated Chassis Management

With the E71, the notion of a higher-level driving dynamics control system was implemented for the first time in a standard model. This central function is also referred to as "Integrated Chassis Management" ("ICM" for short) and is integrated in the control unit of the same name in the E71.



Index	Explanation	Index	Explanation
1	Longitudinal dynamics	ICM	Integrated Chassis Management
2	Lateral dynamics	VDM	Vertical Dynamics Management
3	Vertical dynamics		

The previous strategy was to use one control unit to perform the control tasks for each main movement direction. This approach was not employed in the E71 or the F01/F02.

As is the case in the E71, the new ICM control unit in the F01/F02 essentially performs the calculations for the control functions that influence the longitudinal and lateral dynamics.

The actuators are activated by separate control units (e.g. AL control unit). The functional range of the ICM control unit in the F01/F02 has grown considerably when compared to the E71.

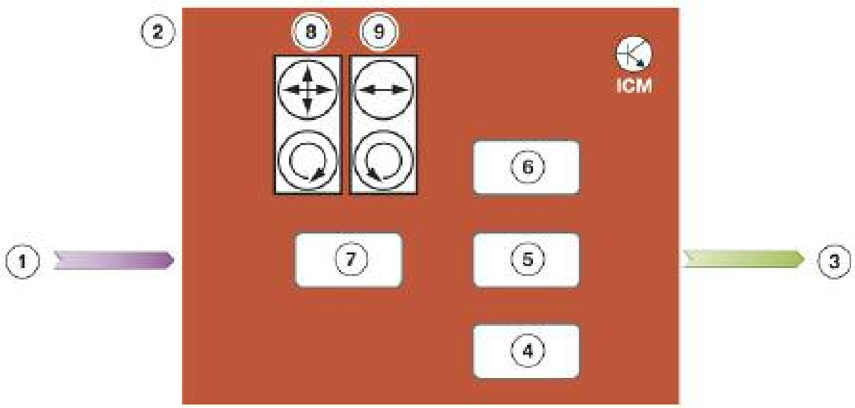
The Vertical Dynamics Management (VDM) is still responsible for controlling the vertical dynamics. The vertical dynamic control and dynamic drive functions are therefore accommodated in the VDM control unit.

Signals that provide information on the current driving situation are obviously exchanged between the ICM and VDM.

The main focus of this section is to describe the functions of the ICM control unit. An introductory overview of these functions is provided in the following sections.

Responsible Control Module (primary processing)	Vehicle Dynamics Systems	Specific Systems
ICM	Longitudinal Dynamics	DSC EMF
	Lateral Dynamics	Servotronic IAL
	Driver Assistance	DCC ACC Stop and Go
VDM	Vertical Dynamics	VDC ARS EHC

Function with ICM Control Module



Index	Explanation
1	Input signals from external sensors
2	ICM
3	Output signals (target values at actuators and actuator control units)
4	Driver assistance functions
5	Central driving dynamics and steering control function
6	Sensor signal processing and signal provision
7	Driving Dynamics control function
8	DSC sensor (integrated in ICM)
9	Redundant DSC sensor (integrated in ICM)

Input Signals from External Sensors

The ICM receives numerous amounts of signal data from various sources which include (but are not limited to):

- Wheel speed information from DSC via FlexRay
- Steering angle from SZL via FlexRay
- Actuator positions from IAL via FlexRay
- Ride height sensors (4) via direct analog input

Output Signals

The ICM processes all signal information and provides this information to other control modules via FlexRay. This information includes wheel speed, steering angle and ride height information. The ICM also makes available, via FlexRay, the information from the integrated DSC sensors. In addition to sensor data, the ICM provides target values for actuators and actuator control units (i.e. AL and HSR).

Driver Assistance Functions

Systems such as ACC Stop and Go and DCC are incorporated into the ICM. In addition, the ICM coordinates the activation of the vibration actuator in the steering wheel for the Lane Departure Warning and Active Blind Spot Detection via a bus signal over the FlexRay.

Central Driving Dynamics and Steering Control Function

The central driving dynamics control system in the ICM firstly evaluates the current driving condition and driver's command, also taking the dynamic driving systems installed in the vehicle into account (i.e. IAL).

On the basis of this information, the system decides whether or not to intervene in the driving dynamics, and also the extent the intervention.

The highly intelligent dynamic driving systems permit slight and barely noticeable interventions as soon as e.g. a tendency towards understeering is detected.

A coordinator function ensures that the most suitable actuator is activated in each case. Where several actuators are used simultaneously, a great deal of importance has been placed on ensuring that these interventions are in perfect harmony.

Signal Provision

The sensors that were previously accommodated separately in the DSC sensor are now installed in the ICM control unit. The following variables can be recorded with these sensors:

- Longitudinal acceleration and pitch of the road or vehicle in the longitudinal direction
- Lateral acceleration and pitch of road or vehicle in lateral direction
- Rotational speed around vertical axis (yaw rate).

The sensor signals are initially referenced to the sensor housing. However, to be useful to the dynamic driving systems, these variables must be referenced to the vehicle coordinate system.

The ICM control unit performs the necessary signal conversion. A synchronization process is carried out when the ICM control unit is started up during which appropriate correction values are determined and saved.

Driving Dynamics Control

The driving dynamics control provides the driver with the choice of one of four driving dynamics settings (Normal, Comfort, Sport and Sport+).

By making this choice, the driver influences the central driving dynamics control system and therefore all dynamic driving systems and drive train systems.

All systems are matched appropriately to every setting and, most importantly, their interaction with each other within one specific setting is also perfectly coordinated.

The status of the Dynamic Stability Control is also taken into account thus ensuring that two additional driving dynamics specifications are possible.

The ICM control unit is also responsible for the Servotronic function including valve actuation. This steering control function is also influenced by the driving dynamics control.

ICM Calibration

Calibration of the sensors integrated into the ICM control unit is necessary in the following cases:

- the ICM control unit has been replaced or
- if requested by the test schedule in the diagnostic system due to a fault code memory entry.

The calibration must be performed with the vehicle standing on a level surface in the longitudinal and lateral direction. The ignition must be switched to Terminal 15.

Higher-level Driving Dynamics Control

Observation of the Driving Condition

The Integrated Chassis Management (ICM) control unit calculates the current driving situation from the signals listed below.
This essentially means the longitudinal and lateral dynamic driving condition:

- Wheel speed signals from all four wheels
- Longitudinal acceleration
- Lateral acceleration
- Yaw rate.

The ICM control unit therefore knows how the vehicle is actually moving at this point. To be able to optimize the vehicle behavior, the dynamic driving systems require information about how the driver wishes the vehicle to move. The driver's command is determined from the following signals:

- Accelerator pedal angle and current engine torque and gear ratio
- Application of the brake pedal and current brake pressure
- Effective steering angle and steering-angle speed (rate).

The driving condition and driver's command are provided both internally and externally by the ICM control unit. The central driving dynamics control acts as a receiver internally in the ICM control unit. The control units of the dynamic driving systems (e.g. DSC) are the external receivers.

They receive the driving condition and the driver's command from the ICM control unit via the FlexRay bus system.

Central Driving Dynamics Control

The aim of the interventions by the dynamic driving system is to improve agility and traction. If required, they can of course also restore the stability of the vehicle.

In previous vehicles, separate systems existed that were designed to do this and although they in fact communicated with each other, they tended to have a more restricted range of tasks.

The interaction of all systems that ultimately determines the overall driving characteristics was therefore difficult to coordinate.

The Integrated Chassis Management of the F01/F02 incorporates the central driving dynamics control. This compares the command given by the driver with the actual movement of the vehicle at that point and therefore determines whether intervention of the dynamic driving system is required, and also the extent of the intervention.

The yawing force is an output variable of the central driving dynamics control system. This produces a rotation of the vehicle that is superimposed on the existing movement of the vehicle. This can be used to "readjust" the driving characteristics if the result identified does not match the driver's command.

Classic examples of this are understeering or oversteering driving characteristics. A new feature of the ICM installed in the F01/F02, however, is that the dynamic driving systems are already deliberately activated before a deviation of this nature is identified.

The interventions of the dynamic driving systems therefore take place long before the driving characteristics become unstable. This produces a far more harmonious effect in the vehicle than would be possible from a conventional chassis design. The vehicle reacts neutrally in many more situations and does not even begin to understeer or oversteer.

This new function is possible through the use of extremely precise computing models and new control strategies that can be used to evaluate and influence the driving characteristics.

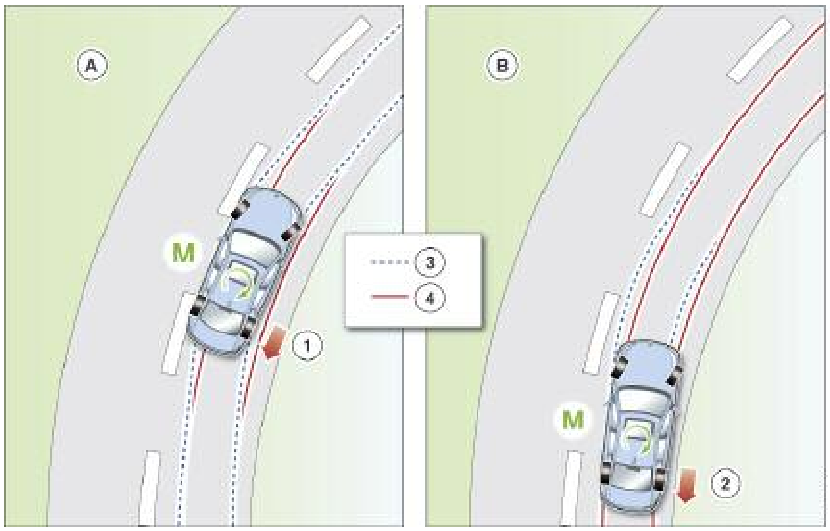
Coordinated Intervention by the Dynamic Driving Systems

The following intervention options for producing the yawing force calculated by the central driving dynamics control system have been available up till now (and will of course remain available) - the corresponding dynamic driving systems are shown in brackets:

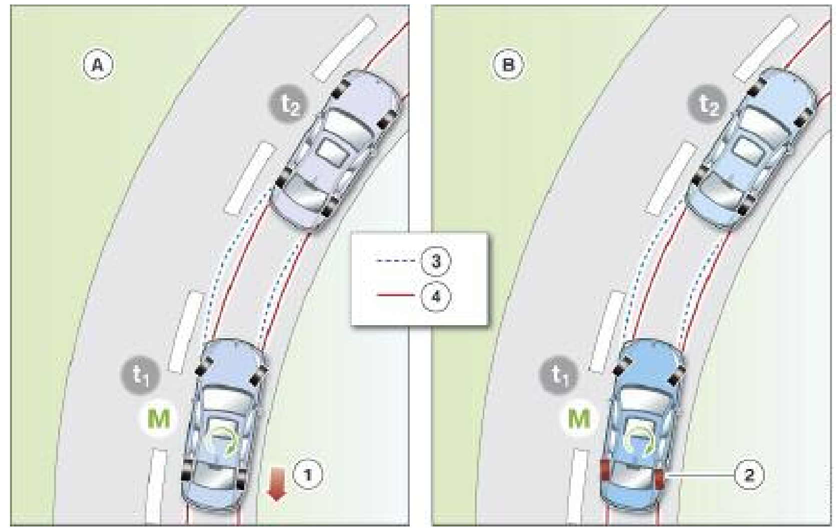
- Individual activation of the wheel brake (DSC)
- Adjustment of the current engine torque (ASC+T, DSC, MSR)
- Adjustment of the steering angle of the front wheels, regardless of the driver's input (Active Steering).

In the F01/F02, the optional Integral Active Steering (IAL) makes available front as well as rear active steering for the first time in a BMW. The rear axle slip angle control (HSR) is only available as an optional package with Active (front) Steering. The two systems together make up IAL.

A function referred to as "Actuator coordination" follows the central driving dynamics control. This decides which dynamic driving system should be used to produce the yawing force in the specific road situation.



Index	Explanation
A	Correction of unstable driving characteristics
B	Intervention at an early stage to achieve neutral driving characteristics
1	Braking intervention at individual wheels in order to **correct** understeering
2	Braking intervention at individual wheels in order to **prevent** understeering
3	Course of an understeered vehicle
4	Course of a vehicle with neutral driving characteristics
M	Yawing force that acts on the vehicle due to braking intervention (at individual wheels)



Index	Explanation
A	Prevention of understeering by means of braking at individual wheels
B	Prevention of understeering by means of steering intervention at rear axle
1	Braking intervention at individual wheels
2	Steering intervention at the rear axle
3	Course of an understeered vehicle
4	Course of a vehicle with neutral driving characteristics
M	Yawing force that acts on the vehicle due to braking intervention (at individual wheels)

For example, if the vehicle has a tendency to sharply understeer this can be counteracted by means of selective braking intervention at the back wheel on the inside of the curve.

If the vehicle is equipped with Integral Active Steering, the same objective can be achieved more seamlessly by applying an appropriate steering angle at the rear axle.

As both actuating options are limited, it may also be beneficial to apply both at once. If understeering is avoided the driver becomes aware of this due to the considerable increase in agility.

The F01/F02 is the first instance where genuine functional networking between the integrated chassis management and Vertical Dynamics Management functions also takes place.

This does not simply mean that the ICM records and processes ride-height information and then delivers it to the VDM.

The ICM is also responsible for the control of the Active Roll Stabilization as an integral part of central driving dynamics control in order to influence the self-steering characteristics.

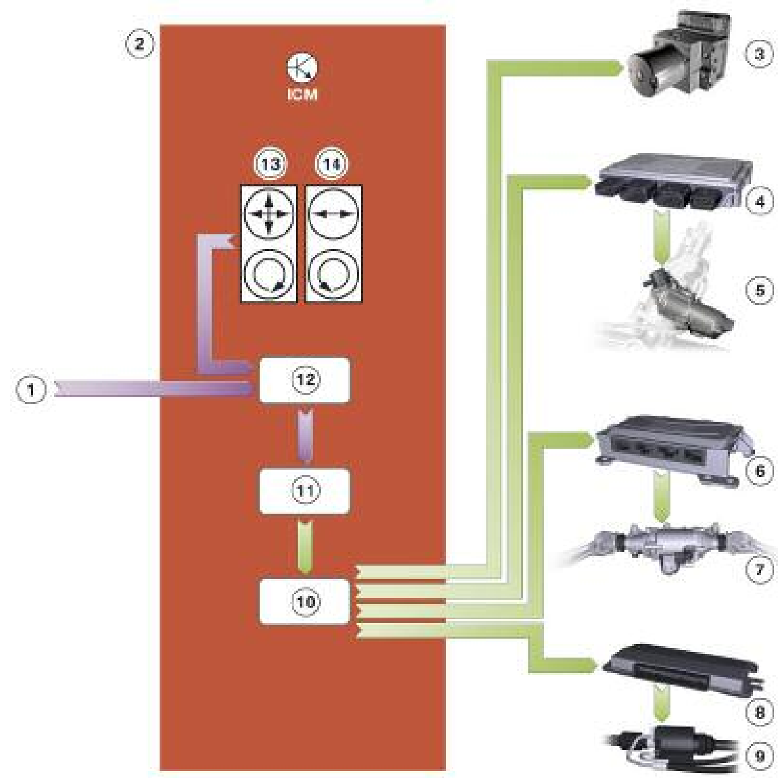
As the conventional chassis design already demonstrates, a more rigid anti-roll bar on one axle means that the overall achievable cornering stability on the same axle is lower.

The effects of more or less rigid anti-roll bars can be emulated with the aid of the hydraulic motors in the anti-roll bars of the Dynamic Drive.

This means that the central driving dynamics control of the ICM can selectively influence the degree of available lateral force on one axle via the active anti-roll bars of Dynamic Drive.

If the vehicle is currently oversteering, the cornering force at the rear axle is insufficient. The roll stabilizing torque at the rear axle tends to reduce in this case. This loss of torque is compensated for by additional cornering stability at the rear axle which helps stabilize the vehicle.

The activity of the central driving dynamics control in the ICM control unit is summarized in the input/output graphic below.

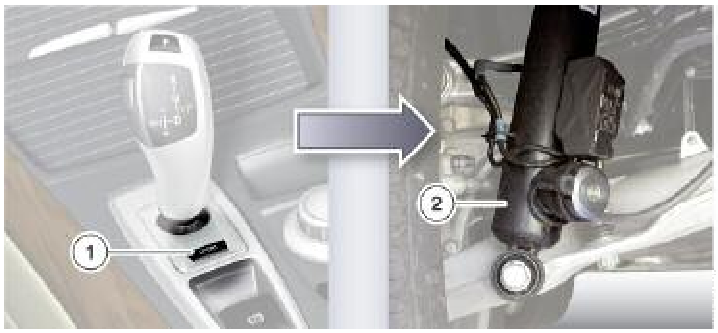


Index	Explanation	Index	Explanation
1	Input signals from external sensors	8	VDM control module
2	Integrated Chassis Management	9	Active anti-roll bar
3	Dynamic Stability Control	10	"Actuator coordination function"
4	AS (AL) control module	11	Central driving dynamics control function
5	AS (AL) actuating unit	12	"Sensor signal preparation" function
6	HSR control module	13	DSC sensor (in ICM)
7	HSR actuating unit	14	Redundant DSC sensor (in ICM)

Driving Dynamics Control

History

Over the years, there have been several versions of switches that modify some aspect of driving dynamics. Some of the earliest versions of these switches included such systems as EDC.
This console mounted switch was usually used to modify the harshness of the damping and included modes such as Comfort or Sport.



Index	Explanation	Index	Explanation
1	SPORT button	2	VDC control with electronically controlled dampers

More recently, these control switches allowed for the functions of multiple systems to be modified. For example, the Z4 used a SPORT switch on the center console to modify throttle response, steering effort and transmission shift characteristics. This switch was referred to as the SPORT button or FDC switch.

More recently, there have been similar switches on various vehicles, although with different functions. For example, the E70/71 uses a SPORT button next to the shifter which influences only the damping control (VDC).

With the introduction of the F01/02, there is a new Driving Dynamics Control switch which influences several systems within the vehicle for maximum control and comfort.

Driving Dynamics Switch

The driving dynamics switch and DTC button are located in the center console. Both the DTC button and driving dynamics switch are ground inputs to the ICM.

Index	Explanation
1	DTC button
2	Driving dynamics switch, SPORT selection
3	Driving dynamics switch, COMFORT selection

The new driving dynamics control in the F01/F02 contains two groundbreaking new features when compared to the E85/E86.

All drive and dynamic driving systems installed in the vehicle are comprehensively switched over via the driving dynamics and DTC switch.

The ICM control unit imports the control signals then determines on the basis of this which new mode the driving dynamics control should adopt.

The driving dynamics switch in the center console allows the selection of 4 modes:

- Sport plus
- Sport
- Normal
- Comfort

In addition to the 4 modes available with the driving dynamics switch, the DTC button allows for 2 additional modes:

- Traction
- DSC off

The driving dynamics system is now capable of several settings. The system affected include:

- DME - Accelerator pedal sensitivity
- EGS - Transmission shift points and shift speed
- Steering - Servotronic and IAL (AL and HSR)
- VDM - damping modes for VDC
- ARS - increased stiffness of the anti-roll bars
- DSC - modes - DTC/DSC Off

The changeover operations for many drive and driving dynamics functions are therefore bundled in the driving dynamics control of the F01/F02. The vehicle as a whole then behaves as the driver would expect in accordance with his/her chosen setting.

Conversely, many individual, and also sometimes meaningless, combinations are avoided (example: sports steering combined with comfort-oriented damping).

The ICM control unit also prompts the display of the relevant mode in the instrument cluster and also in the Central Information Display. In addition to selecting a mode, the driver can use the controller to make further settings.

Index	Explanation
1	DTC Button
2	Driving Dynamics Switch (FDC)

Operation and Display

After the vehicle is started, the driving dynamics control is always in "Normal" mode.

The switch will change the 4 modes of driving dynamics in a sequential manner. Each subsequent press of the switch will move through the 4 modes in either direction.

The modes will be displayed under the the tachometer as shown. After a few seconds, a more compact display will be shown after the switch is no longer pressed.

Driving dynamics mode display

Compact display

The DTC button provides the driver with two additional modes, Traction (DTC) and DSC off.

The "Traction" mode can be activated by briefly pressing the DTC button. This works irrespective of which driving dynamics control mode was previously active. "DSC off" is activated by holding the DTC button pressed for a longer period.

The "Traction" and "DSC off" modes can be switched off by pressing the DTC button again. The driving dynamics control subsequently returns to "Normal" mode.

The two modes "Traction" and "DSC off" present a special case in terms of their display requirements. In addition to the text entry, the yellow DSC indicator and warning lamps must be activated.

"Traction" display (DTC)

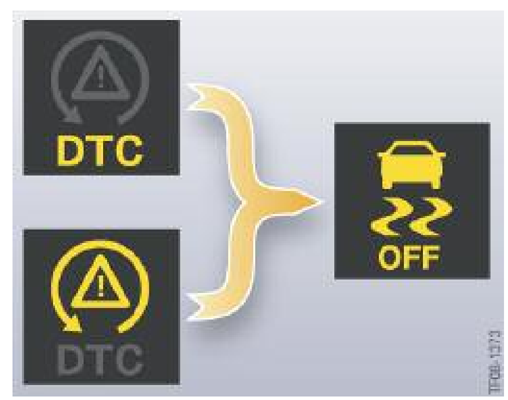
"DSC off" display

The new DSC symbols used for the first time in the F01/F02 replace the symbols previously used.

Two different symbols were formerly used for the two states "DTC mode" and "DSC off" and were displayed in the instrument cluster.

Since the launch of the F01/F02, only one symbol has been used for both states. The new symbols are being gradually introduced in all newly developed vehicles.

The reason for this are changes to legislation that require automobile manufacturers to produce a uniform display format. This legislation also specifies that the text message "off" must be displayed as soon as the DSC function is restricted, as is the case in the "Traction" and "Sport+" modes.



When the DTC button or the driving dynamics switch is pressed, there is an additional assistance window which appears in the CID.

The name of the newly selected mode appears there together with an explanatory text. This assistance window can be turned on or off via the Settings/Central Display option in the CID.

In the "Sport" mode, the driver also has the option of configuring which systems are affected by this selection. Assisted by the controller, the driver can choose whether to apply the "Sport" mode to the drive systems, or the dynamic driving systems or both.

Workshop Exercise - Driving Dynamics Control

Using an instructor assigned F01, use the driving dynamics control switches and DTC Button to select the various modes in driving dynamics. Follow the exercise below:

Using the driving dynamics switch, toggle between the various modes (i.e. Sport, Comfort etc.).

Does anything change in the CID?

Using the controller, go to the following menu:

"Settings > Control Display"

and check the box for "Display Driving Settings".

Repeat the first step by toggling through the various driving dynamics modes.

What is different about the CID display?

Switch to Sport Mode.

What options are available in the CID?

What changes are possible to the driving dynamics?

Using the controller, go to the following menu:

"Vehicle Info > Owner's Manual"

and enter the selection for "Dynamic Driving Control".

Scroll down until you see the text "Automatic Program Change" and read about the conditions in which the driving dynamics will switch to "NORMAL".

Under what conditions will the driving dynamics switch to "NORMAL"?

In the main menu of the "owners manual", look for Active Cruise Control.

What happens to the driving dynamics setting when the Active Cruise Control is switched on while driving?

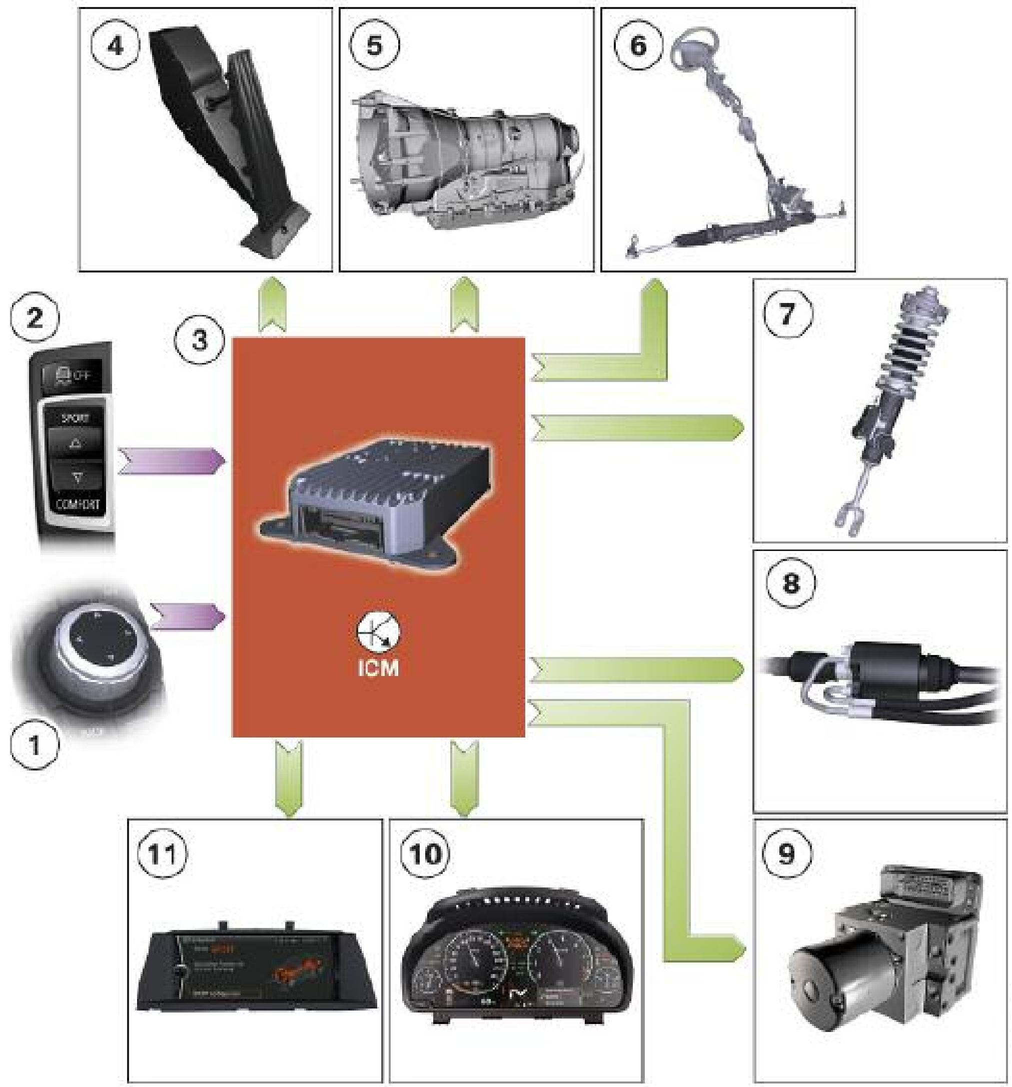
Workshop Exercise - Driving Dynamics Switch Modes

Using the supplied posters, work with your instructor to determine which driving dynamics systems are affected by the driving dynamics and DTC switches. Complete exercise by filling in the chart below.

Vehicle Systems	Driving Dynamics Switch				DTC Switch		
	Comfort	**Normal**	**Sport**	**Sport +**	**Normal**	**Traction**	**DSC Off**
Drive Systems							
Accelerator pedal characteristic		Normal					
Shift program, automatic transmission		Normal					
Shift speed, automatic transmission		Normal					
Chassis and dynamic driving systems							
Power steering assistance		Normal					
Integral Active Steering (IAL)		Normal					
Dynamic Stability Control (DSC)		DSC On					
Vertical Dynamics Control (VDC)		Normal					
Active Roll Stabilization		Normal					

Workshop Exercise - Modes of Driving Dynamics

Using the illustration below, complete the exercise as outlined on the following pages.



Workshop Exercise - Driving Dynamics Switch Modes

Using the graphic on the previous page and the poster chart, work with ISTA to complete the chart below:

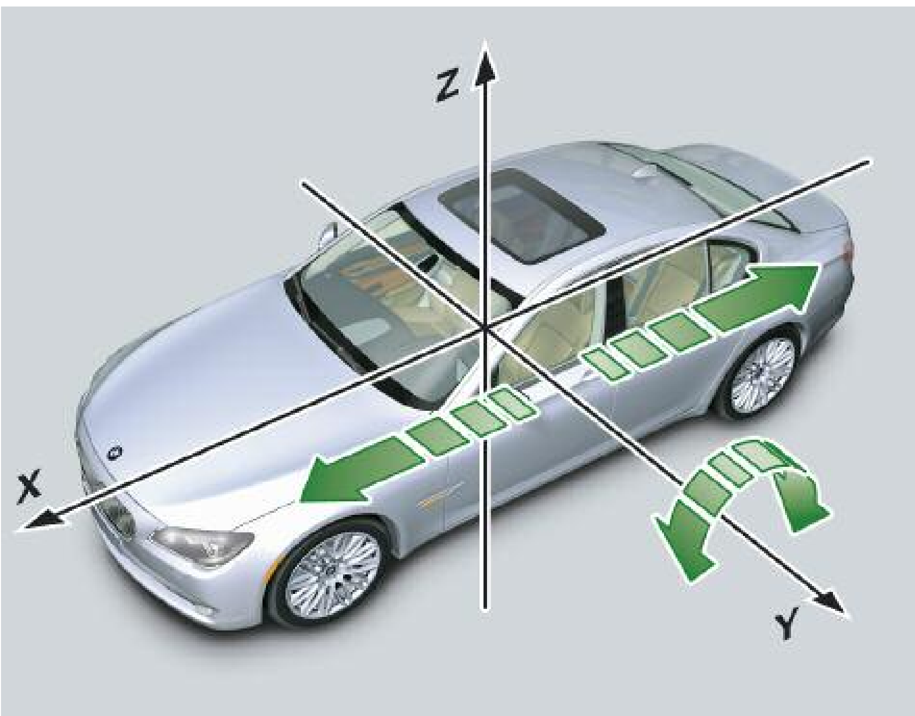
Index	Explanation	Communicates with	Via Pathway	For (function)
1	Controller	ICM		
2	Driving Dynamics Switch	ICM		
2 b	DTC Button	ICM		
3	ICM	All drive and drive dynamics systems		
4	Accelerator pedal/DME	ICM		
5	Automatic transmission/EGS	ICM		
6	Steering- Servotronic	ICM		
6 b	Steering - IAL	ICM		
7	VDC/VDM	ICM		
8	ARS/VDM	ICM		
9	DSC	ICM		
10	Instrument cluster	ICM		
11	CID	ICM		

Longitudinal Dynamics

For the F01, the longitudinal dynamics systems described in this document include the following:

- Dynamic stability control (DSC) and
- Electromechanical parking brake (EMF).

Both DSC and EMF are standard equipment on all F01/F02 models. Both systems are based on the technology used on the E70/E71.



However, many specific details have had to be changed. Those changes were essential to ensure that DSC and EMF could be seamlessly integrated in the new dynamic handling system complex on the F01/F02.

As far as the Dynamic Stability Control was concerned, coordination with the central dynamic handling controller on the ICM master control unit had to be taken into consideration.

And the new "dynamic handling control" function also affects the way the DSC operates. The thresholds and the nature of the DSC interventions have to be adapted to suit the setting selected.

Thus the DSC doesn't simply contain a setting that suits a luxury class vehicle such as the F01/F02. Instead, several different chassis settings have been developed which correspond to the characteristics of the various dynamic handling control settings.

In addition to adaptation to handling characteristics, there are numerous other changes to the Dynamic Stability Control on the F01/F02 which relate to location, display features, fault diagnosis and repair.

Starting from the basis of the system on the E70/E71, the electromechanical parking brake has been adapted to the requirements of the F01/F02. That includes such things as component location and attachment to the vehicle.

In addition, design enhancements have been introduced to make the EMF actuator quieter in operation.

DSC F0x

The Dynamic Stability Control on the F01/F02 (DSC F0x) includes many of the same functions as on the E70/E71 (DSC E7x).

As the DSC F0x is based on the same highly advanced technology as the DSC E7x, all DSC functions on the F01/F02 achieve outstanding performance in terms of:

- dynamic response (brake pressure can be generated extremely quickly)
- control precision (brake pressure can be adjusted extremely precisely and without significant fluctuation)
- noise emission (operation of the valves and the hydraulic pump is quieter than the previous generations)
- tactile response (unpleasant feedback from the brake pedal has been substantially reduced, e.g. pedal vibration during brake modulation).

Differences between the DSC functions on the E70/E71 and F01/F02 arise from the different drivetrain configurations (4-wheel drive/rear-wheel drive).

Therefore, the DSC F0x does not include the "Hill Descent Control (HDC)" function specific to 4-wheel drive vehicles.

Instead of the 4-wheel-drive version of the automatic differential brake (ADB-X), the DSC F0x uses the version for vehicles with rear-wheel drive (ADB).

A new subfunction of the ADB is that traction control brake modulation is available even when the DSC is switched off. This subfunction is called "Electronic Differential Lock Control" and is described in the following pages.

DSC Functional Overview

Function	DSC ON	Traction	DSC OFF
Anti-lock braking system (ABS)	●	●	●
Electronic brake force distribution (EBV)	●	●	●
Cornering Brake Control (CBC)	●	●	●
Engine drag torque control (MSR)	●	●	●
Automatic Stability control (ASC)	●	X	
Automatic Differential Brake (ADB)	●	X	X
Dynamic Handling Control (FDR) *	●	X	
Brake modulation for increased agility	●	●	
Dry braking	●	●	●
Start assist	●	●	●
Braking readiness	●	●	●
Fading assistance	●	●	●
Dynamic Brake Control (DBC)	●	●	●
“Auto Hold” combined with EMF *	●	●	●
Condition based service	●	●	●

Symbols:

* indicates that the function can be switched on/off by the driver

● indicates that the function is active

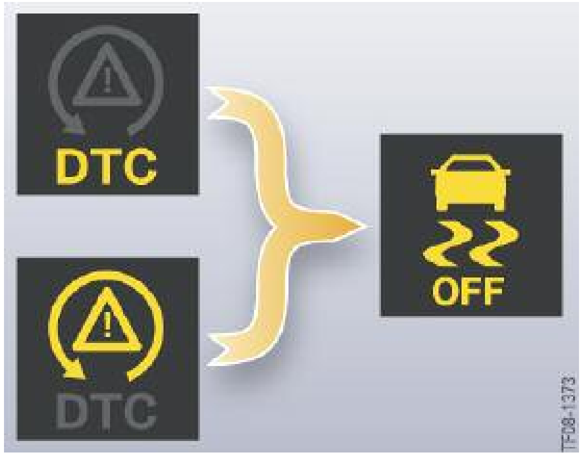
X indicates that the function has adapted control thresholds

DSC Displays and Controls

New DSC Symbols

There is a new set of symbols for the indication of DSC operation. Starting on the F01/F02, this new DSC symbol set replaces the symbols previously used.

Previously, there were two different symbols displayed on the instrument cluster for the statuses "DTC mode" and "DTC off". As of launch of the F01/F02, there is now only one symbol for both statuses.



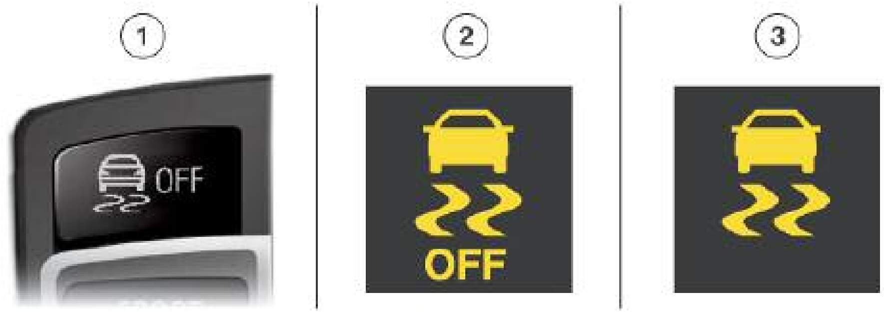
However, the driver can distinguish between the two statuses by means of additional information in text form.

The new DSC symbol set relates not only to the display but also the labeling of the DTC button.

The new symbols will gradually be introduced on all new vehicles as they are phased in. The reason for the change of symbols are the new legal requirements which oblige all car manufacturers to use standardized display symbols.

That will enable motorists to immediately recognize the controls and displays of a DSC system as such regardless of the brand of car they are driving.

The regulations also require that even merely limited DSC function must result in display of the word "off". That is the case in "DTC mode", in which the stabilizing interventions take place at a later stage.



Index	Explanation
1	DTC button
2	DSC indicator and warning lamp on the instrument cluster DSC switched off, or DSC in DTC mode
3	DSC indicator and warning lamp on the instrument cluster DSC control sequence active (flashing) or DSC failure (permanently lit)

DSC Modes

As familiar from previous vehicles, the Dynamic Stability Control on F01/F02 incorporates the following function modes:

- DSC on
- DTC (Dynamic Traction Control)
- DSC off.

In the "DSC on" mode, all DSC functions are fully active. The stabilizing interventions in brake and engine function take place at an early stage. That makes it easier for less expert drivers to regain control of a vehicle that is becoming unstable.

In "DTC mode" the stabilizing interventions take place at a slightly later stage. The Automatic Stability Control and Automatic Differential Brake functions allow a greater degree of wheelspin. That improves traction when pulling away on loose surfaces such as uncompacted snow.

The dynamic handling control function does not come into action until a larger sideslip angle is reached than in "DSC on" mode.

In "DSC off" mode, the stabilizing interventions by the Dynamic Handling Controller and the Automatic Stability Control are switched off.

Especially safety-critical DSC functions such as ABS remain fully active in all DSC modes, however.

The mode "DSC off" is aimed at the undiluted driving experience, the direct connection between the driver, vehicle and the road.

Integration in Dynamic Handling Control

A new feature of the DSC modes on the F01/F02 is that they are integrated in the dynamic handling control function and can be activated by the console mounted DTC and driving dynamics buttons.

DSC Functions in Detail

ADB active even when DSC is off

The DSC function ADB has been around for a long while on a wide variety of BMW vehicles and especially in the form of the ADB-X version on the xDrive models.

If one of the wheels of a driven axle is spinning, it cannot transmit any driving force (torque) to the road. And because the differential distributes the torque equally between the two wheels, the other wheel on the axle can not transmit any driving force either.

ADB brakes the spinning wheel so that the driving torque and braking force are in equilibrium on that wheel. Then, by virtue of the differential, an equal amount of driving torque is applied to the wheel that is not spinning.

And because that wheel is offered grip by the road surface, a driving force can be transmitted that results in forward motion of the vehicle.

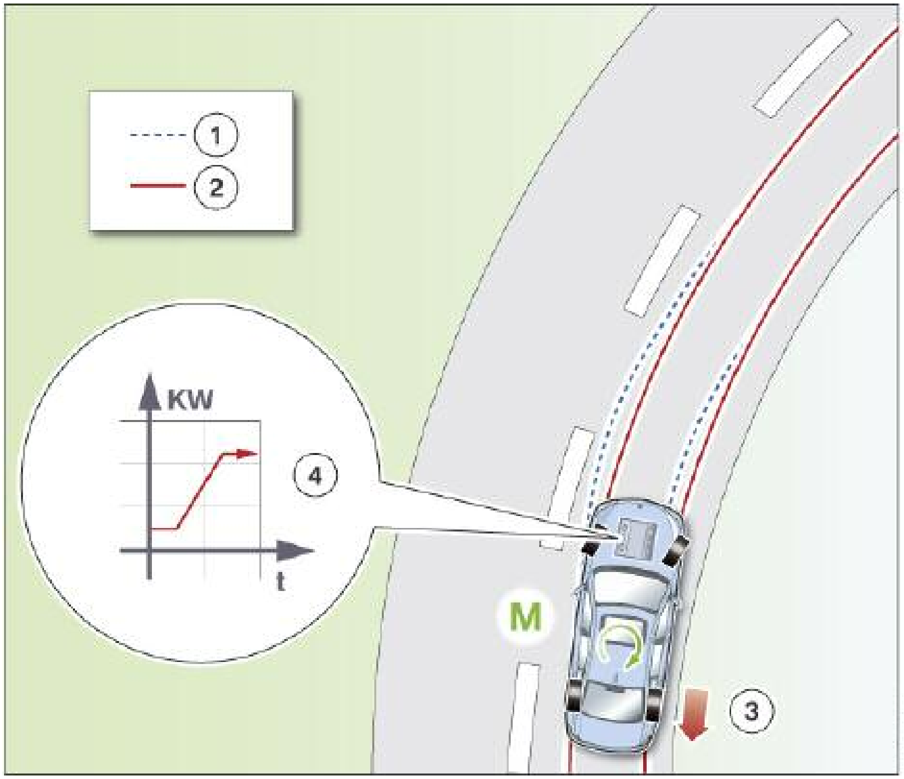
Thus ADB increases traction on slippery surfaces and has a similar effect to a differential lock.

- On the xDrive models, ADB-X remains active even when the DSC is switch off in order to achieve improved traction.
- On vehicles with rear-wheel drive, that individual braking of the driving wheels was previously only active when the DSC was active or in "DTC" mode.
- On the new F01/F02 (as well as the 135i and E9X) that ADB subfunction remains active even when the DSC is switched off.

That function is called "Electronic Differential Lock Control" and uses the DSC to emulate the effect of a differential lock on the driving wheels. In contrast with previous arrangements, such brake modulation for the purposes of increasing drive transmission takes places even if the driver has switched off the DSC.

Brake Modulation for Increasing Agility
The highly advanced hardware of the DSC F0x enables brake modulation to be carried out without unpleasant feedback for the driver.

On the F01/F02, that capability is utilized to influence the vehicle's self-steering characteristics is a specifically targeted way.



Index	Explanation
1	Course of an understeering vehicle
2	Course of a vehicle with neutral handling
3	Individual modulation of brakes to prevent understeer
4	Increased engine torque to compensate for braking force
M	Yaw force acting on the vehicle as a result of individual wheel braking

If the vehicle begins to understeer, e.g. when cornering quickly, the central dynamic handling controller on the ICM detects the very first indications that it is starting to happen.

A required setting is transmitted to the DSC requiring it to apply the brake on the rear wheel on the inside of the bend.

The DSC sensitively applies the required setting and without generating a level of noise perceptible by the driver. The uneven braking effect thus produced, creates a yaw force acting around the vehicle's center of gravity.

As a result, the vehicle turns towards the inside of the bend, doesn't understeer and corners with absolutely neutral handling.

This type of brake modulation increases road safety because it prevents the vehicle drifting towards the outside of the bend. The disadvantage, however, is that the vehicle is slowed slightly by the application of the brake and thus a degree of momentum is lost.

In this case, the solution is taken a step further. Whenever handling stability considerations allow, the engine torque is increased simultaneously with brake application.

The higher engine torque is transmitted to the road by the wheel on the outside of the bend that is not being braked. The control strategy ensures that the increase exactly matches the retardation by the brake application.

While that DSC function is active, there is no display of any kind on the instrument cluster. In that way, highly advanced components (DSC) and intelligent control strategies are combined to produce an overall effect that substantially improves agility without impairing the handling stability of the vehicle.

Automatic Hold

This function has been around since the E65, on which it was called "Auto-P". The Automatic Hold function was also used on the E70/E71.

As with the previous Auto-H equipped vehicles, this function works in conjunction with DSC to provide the needed brake pressure.

The EMF module and actuator are also used to apply the parking duo-servo parking brake when the engine is off.

When the Automatic Hold function is active, the driver first of all brakes the vehicle to a standstill. It is then held stationary by the DSC hydraulic modulator.

That is achieved by maintaining the final brake pressure applied by the driver. If the vehicle starts to roll on an incline, the DSC hydraulic modulator actively generates brake pressure. Pressing the accelerator causes the brake pressure to be released and the vehicle starts to move again.

After the engine is started, the function can be activated until the next time the engine is switched off. To do so, the driver's door must be closed and the driver's seatbelt fastened.

The function can, of course, also be manually deactivated before the engine is switched. The footwell module reads the signal from the door switch. The ACSM control unit analyzes the signal from the seat belt buckle contact.

The two signals are transmitted to the DSC control unit via the bus systems. One signal that is not analyzed for the Automatic Hold function on the F01/F02 is the driver's seat occupancy signal.

Conversely, the Automatic Hold function is automatically deactivated if the driver's door is opened and the driver's seatbelt unfastened. To prevent the vehicle rolling away in that situation, the EMF parking mode is activated.

As long as the engine is running, the parking mode is effected by means of the DSC hydraulic modulator. If the driver switches the engine off, the function is taken over by the EMF actuator unit.

Before the vehicle is driven into a car wash, the Automatic Hold function has to be deactivated as otherwise the brakes are applied when the vehicle is stationary and it can not be rolled.

The Automatic Hold function is activated and deactivated by means of the button marked "AUTO H" on the center console. There is an LED in the button as well as an indicator on the instrument cluster.

The various function statuses and how they are indicated are summarized on the following page.

Slide Detection

When Automatic Hold is holding the vehicle stationary, two additional internal DSC subfunctions are activated: roll-away monitoring and slide detection.

The roll-away monitoring function is described in EMF section.

The slide detection function is designed to intervene if the vehicle starts to slide after stopping, i.e. if all four stationary wheels start to slip on a slippery surface on a hill. If the driver were holding the vehicle stationary and became aware of such a situation, he/she would release the brake. In that way the vehicle can at least be steered as it rolls down the slope.

The slide detection function is based on exactly the same principle. When the vehicle is being held stationary by Automatic Hold, the slide detection function monitors the signals from the wheel-speed sensors.

The DSC alternately releases the pressure on one of the brakes in while keeping the others under pressure. If the DSC detects a movement from the wheel on which the brake is released, then obviously the entire vehicle must be moving.

Status of Auto-H Function	Status of indicator lamp (in button)	Status of indicator lamp (in cluster
Switched Off		
Switched On and on Standby (vehicle moving)		
Switched On and Active (vehicle stationary)		
Deactivated by driver exiting vehicle or switching engine OFF		

That means that the other wheels, on which the brakes are applied, must be sliding while locked. Under those circumstances, the condition "sliding" would be detected.

The response to detection of sliding is progressive release of brake pressure so that the vehicle becomes steerable. The driver is made aware of the critical situation by a CC message and an audible warning signal.

Interface for Adaptive Braking Assistance
The function "Adaptive Braking Assistance" implemented as a co-ordinated strategy by the DSC and ACC with Stop & Go function.

The interface relates to two functions on the DSC:

- brake standby and
- dynamic braking control.

"Brake standby" can be activated by a request signal transmitted by the ICM control unit. That happens when a potential collision situation has been detected with the aid of the radar sensors.

Brake standby is also activated if the internal DSC criteria familiar from previous models are met (minimum speed, rapid release of accelerator pedal).

The threshold for triggering dynamic braking control can be influenced by ACC Stop & Go. If a potential collision situation is detected, the ICM control unit sends out a signal requesting lowering of the activation threshold. To be precise, the activation threshold is the rate of increase of brake pressure applied by the driver that has to be exceeded in order to dynamic braking control (braking assistance).

That makes it easier for the driver to trigger dynamic braking control. This function is the only means by which a driver braking hesitantly can activate dynamic braking control.

Relationship of DSC and ICM

On previous vehicles, the DSC control unit contained the central dynamic handling control functions. A dynamic handling control complex remains part of the DSC F0x.

However, it is controlled by the central dynamic handling controller on the ICM (as are the other dynamic handling systems).

The ICM calculates the current handling status and the vehicle response desired by the driver. To do so, it makes use not only of the signals from the DSC sensor integrated in the ICM but also of those from external sensors such as the steering angle sensor and the wheel-speed sensors.

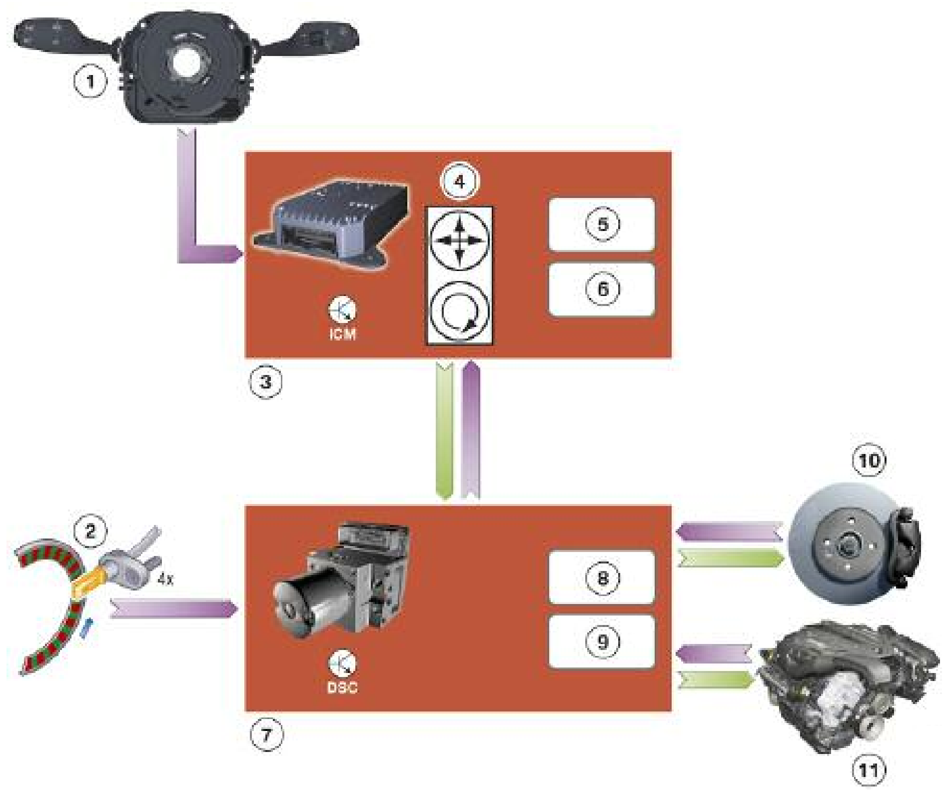
If a difference between the response desired by the driver and the reaction of the vehicle is detected, the central dynamic handling controller on the ICM calculates a required compensatory yaw force.

The purpose of that yaw force is to bring about a yawing motion on the part of the vehicle that is superimposed over the existing movement of the vehicle. In that way, the vehicle handling can be corrected retrospectively, so to speak, when it threatens to become unstable.

The highly advanced DSC technology and the central dynamic handling controller on the ICM even make is possible to optimize handling characteristics in advance.

Subordinate to the central dynamic handling controller on the ICM is an "actuator coordination" function. It decides whether and to what degree the DSC dynamic handling system is to contribute to producing the required yaw force.

The required force is signalled to the DSC's dynamic handling controller, which puts it into action by operating the actuators represented by the brakes and drivetrain.



Index	Explanation	Index	Explanation
1	SZL (and Steering Angle Sensor)	7	DSC
2	Wheel speed sensors	8	Dynamic handling control function (on DSC)
3	ICM	9	Actuator control function on DSC
4	Integral DSC sensors (lateral/longitudinal/yaw rate)	10	Brake
5	Dynamic handling control function (on ICM)	11	Powertrain
6	Actuator coordination function		

Simple implementation of the settings specified by the ICM is, however, not the only task of the DSC's dynamic handling controller on the F01/F02. It also continues to independently perform the following original DSC functions:

- Anti-lock braking system (ABS)
- Cornering Brake Control (CBC)
- Automatic Stability Control (ASC)
- Engine drag torque control (MSR)
- Automatic Differential Brake (ADB)

The numerous additional functions over and above pure handling dynamics control are also carried out largely independently by the DSC and without intervention by the ICM:

- Functions which help to reduce stopping distance: they include brake drying, brake standby, brake fade prevention and dynamic brake control. The efficiency of the brake standby and dynamic brake control functions is further improved in combination with the "ACC Stop & Go" option.
- Convenience functions which make driving easier, e.g. Automatic Hold, which is performed by the DSC and EMF in combination.
- The stresses on and wear of brake components are monitored with the aid of computation models. Based on information such as brake pressure and brake temperature and the signals from the brake-pad wear sensors, a remaining service life expressed as a mileage is calculated. The owner can view that information as a subfunction of Condition Based Service and use it as an aid to planning servicing appointments.

Electromechanical Parking Brake (EMF)

The EMF is applied/released by means of the parking brake button on the center console control panel. The parking brake status is indicated by the function indicator lamp on the button and an indicator lamp on the instrument cluster.

The EMF can be applied in all logical terminal statuses (Terminal 0, Terminal R, Terminal 15, Terminal 50).

The conditions for release of the EMF are:

- Terminal 15 active and brake pedal depressed or
- automatic transmission parking lock engaged.

Emergency Release

The EMF can be released in an emergency by means of a cable. That cable is accessible through the trunk and is under the trunk floor trim. To effect emergency release of the EMF, the red T-shaped handle from the vehicle tool kit is required.

Caution: Secure vehicle to prevent it rolling before operating the emergency release!

After a power supply failure, it may still not be possible to move the vehicle even after releasing the brake with the emergency release facility. The automatic transmission parking lock may still be engaged. In that case, the parking brake must first be released using the emergency release method.

Then, the automatic transmission parking lock must be released using the emergency release facility. The tool must remain engaged in the parking lock emergency release for that purpose.

When the parking brake is to be used again after an emergency release, it can only be done by pushing in the parking brake button.

The familiar conditions for releasing the parking brake must also be met.

Installation Mode

Installation mode sets the EMF actuator unit to the installation position (brake cables extended to maximum). It also prevents the EMF being accidentally applied, e.g. when carrying out repairs. 1

Installation mode can be cancelled either by means of a service function or by driving the car.

Running-in the Brakes

While running-in the parking brakes, the EMF applies a defined force to the duo-servo parking brakes.

The function for running-in the parking brakes only has to be carried out if:

- the linings of the duo-servo parking brakes have been replaced or
- the rear brake discs have been replaced.

The precise procedure for running-in the parking brakes is described in the Repair Instructions under the heading "Adjusting the parking brake". The instructions given there must be followed exactly.

EMF Actuating Unit

The EMF actuator unit is made up of the following main components:

- EMF control unit
- Electric motor
- Gearbox
- Force sensor.

In the event of a fault, the EMF actuator unit can only be replaced as a complete unit.

The following are available as separate parts:

- the EMF actuator unit itself
- the bracket for the EMF actuator unit and
- the cables.

The EMF control unit detects vehicle standstill on the basis of the following signals:

- Road speed (from ICM)
- Rear axle speed (calculated from DME)
- Wheel-speed signal "DFA_EMF" (from DSC).

Only when those three signals definitively indicate vehicle standstill does the EMF control unit allow operation of the actuator unit.

The EMF control unit is connected to the PT-CAN. Integrated in the EMF control unit is a terminal resistor for the PT-CAN.

The EMF control unit is connected to the wake-up line.

If the driver operates the parking brake button at Terminal 0, the EMF control unit is woken up. The EMF control unit in turn wakes up the other control units on the vehicle via the wakeup line.

On vehicles with the Integrated Active Steering optional extra, the bracket for the EMF actuator unit is bolted to the bracket for the HSR actuator.

On vehicles without Integrated Active Steering, the bracket for the EMF actuator unit is bolted to the rear suspension subframe.

Roll-away Monitoring

The roll-away monitoring function is computed on the DSC control unit. It is active while the vehicle is being held stationary by:

- the DSC hydraulic modulator or
- the EMF actuator unit.

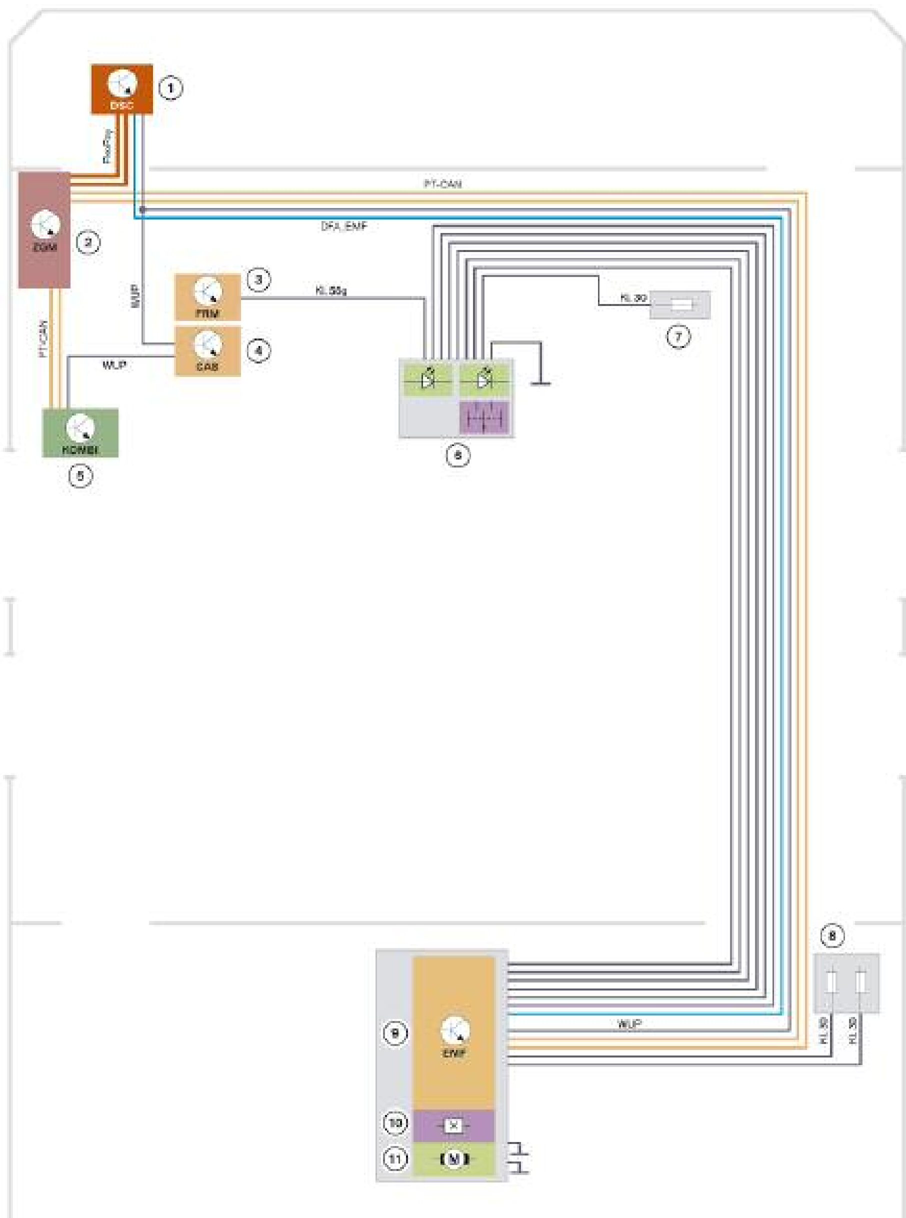
The condition for activation of roll-away monitoring is thus that either the EMF parking brake function or the Automatic Hold function is active.

Roll-away monitoring observes the signals from the wheel-speed sensors. If any of the wheel-speed sensors signals movement of the wheel, that indicates that the vehicle is rolling.

Since, however, the vehicle is supposed to be stationary by virtue of the brake pressure applied by the hydraulic system or the EMF actuator, the roll-away monitoring function has to intervene.

The hydraulic brake pressure is increased by control signals to the DSC hydraulic modulator or EMF electric motor in order to increase the braking force. In that way the rolling is counteracted.

Schematic EMF



Index	Explanation
1	Dynamic Stability Control
2	Central Gateway Module
3	Footwell Module
4	Car Access System
5	Instrument cluster
6	Parking brake button with function indicator and illumination
7	Fuse for parking brake button (front fuse board, junction box electronics)
8	Fuses for EMF electronics and electric motor (rear fuse board in trunk)
9	EMF control unit
10	EMF force sensor
11	EMF electric motor

Classroom Exercise - Review Questions

1. To which module are the ride height sensors connected and how are they connected?

2. What criteria determines which version of the ICM will be installed? (i.e. High or basic version)

3. Which control module contains the DSC sensors (yaw etc.)?

   DME AL HSR DSC ICM

4. Which two control modules below contain the "dynamic handling controller" functions? (circle 2)

   DME AL HSR DSC ICM

5. Two technicians are discussing the DSC sub-function of ADB on the F01.

   Technician A says that the ADB function is active when the DSC is OFF.

   Technician B says that the ADB function is active when DSC is ON.

   Who is correct?

   A. Technician A B. Technician B
   C. Both A and B D. Neither

NOTES PAGE

Lateral Dynamics Systems

In this section of the training manual, the systems covered include:

- Servotronic for F01/F02
- Integrated Active Steering (IAL)

IAL represents the combination of the already familiar Active Steering (front) and the new Rear Axle Slip Angle Control (HSR).

Integrated Active Steering

Integrated Active Steering is an innovative and logical development of the Active Steering system developed by BMW.

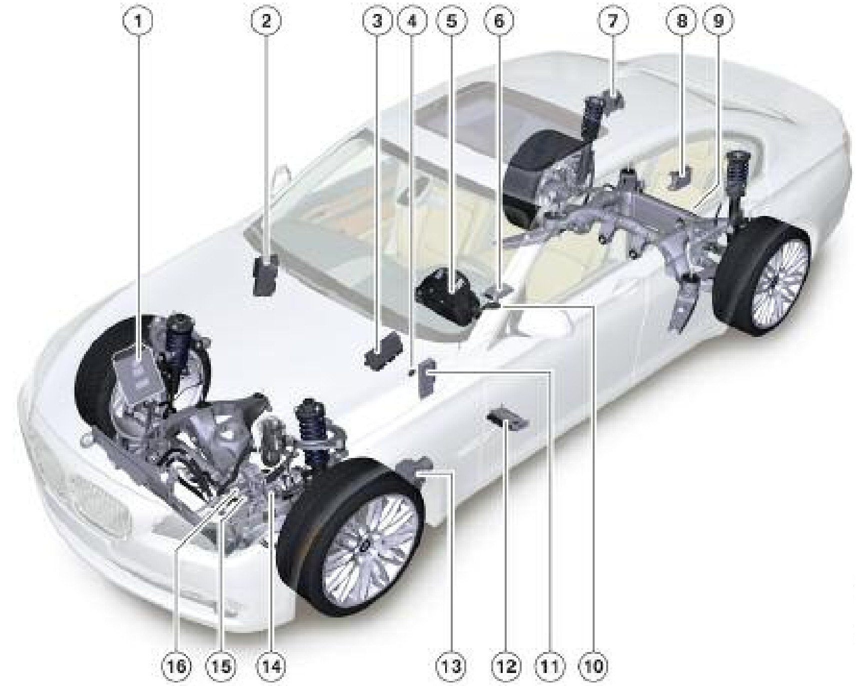
With Active Steering, a steering angle amplification factor reduces the steering effort on the part of the driver and combines the capabilities of "steer by wire" systems with authentic steering feedback.

By intervening in the steering independently of the driver's actions, it is also able to perform a stabilizing function in terms of vehicle handling.

In order to move further ahead in terms of handling dynamics, the familiar Active Steering has now been logically extended by the addition of active rear-wheel steering on the new BMW 7 Series.

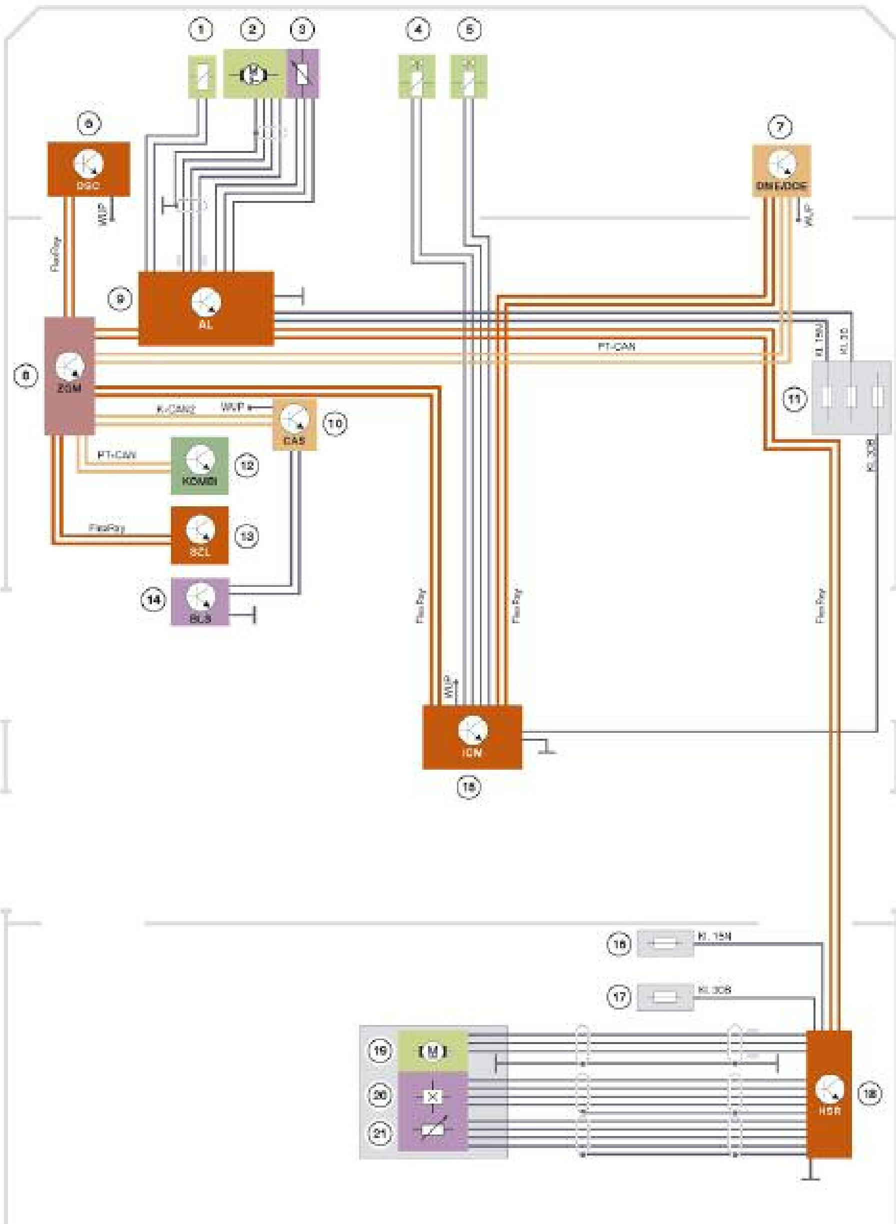
Active Steering of the rear wheels is a logical extension of Active Steering and the two are now combined as an all-in one system referred to as Integrated Active Steering.

Integrated Active Steering is available as an option on the F01/F02 because the standard steering system is the Servotronic.



Index	Explanation	Index	Explanation
1	DME	9	Rear-wheel steering actuator (HSR)
2	Front power distribution box	10	SZL
3	CAS	11	ZGM
4	Brake light switch	12	Active Steering actuator control unit
5	Instrument cluster	13	DSC
6	Integrated Chassis Management (ICM)	14	Active Steering actuator motor with motor angular position sensor and lock
7	Rear power distribution box	15	Electronic volumetric flow control (EVV) valve
8	HSR control unit	16	Servotronic valve

Schematic, Integral Active Steering



Index	Explanation	Index	Explanation
1	Active Steering lock	12	Instrument cluster
2	Active Steering electric motor	13	Steering column switch cluster
3	Active Steering motor angular position sensor	14	Brake light switch
4	Electronic volumetric flow control (EVV) valve	15	Integrated Chassis Management
5	Servotronic valve	16	Right rear power distribution box
6	Dynamic stability control	17	Battery power distribution box
7	Digital Motor Electronics	18	Rear suspension slip angle control
8	Central Gateway Module	19	HSR electric motor
9	Active Steering	20	Hall-effect sensor
10	Car Access System	21	Track-rod position sensor
11	Front power distribution box		

Overview

Implementation of the Integrated Active Steering function has essentially been made possible by the new ICM system complex on the F01/F02.

The Servotronic function including valve control is also taken over by the ICM control unit. That steering control function is also influenced by the driving dynamics control switch.

Advantages of Integrated Active Steering:

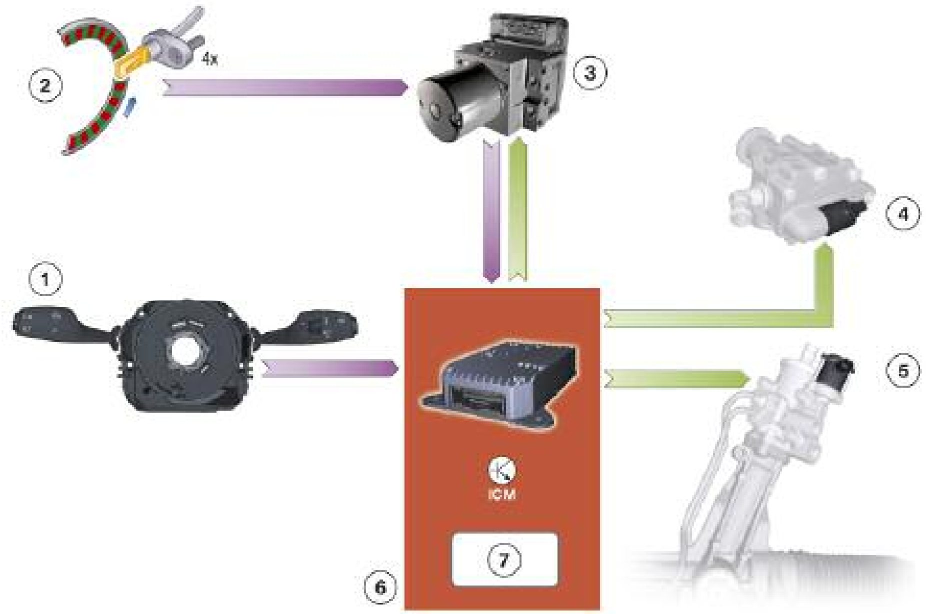
- Extension of Active Steering (AL) by the addition of rear-wheel steering (HSR)
- Variable steering-gear ratio (steering angle amplification factor)
- Independent control of rear-wheel steering angle (steer by wire)
- Servotronic
- Handling stabilization functions
- Reduction of braking distance under split surface braking conditions.

Signals from External Sensors

The ICM control unit reads the following signals that are essential to the Integrated Active Steering from external sensors:

- Four wheel-speed signals sent via Flexray by the DSC
- Steering angle sent via FlexRay by steering column switch cluster
- Status of AL and HSR actuators transmitted via Flexray.

However, because the rear-wheels are steerable, the steering angle of the front wheels alone is not definitive for dynamic handling control purposes.



Index	Explanation	Index	Explanation
1	SZL	5	Servotronic valve
2	Wheel speed sensor	6	Integrated Chassis Management
3	Dynamic Stability Control	7	“Steering Control” function of ICM
4	Electronic volumetric flow control valve (EVV)		

Therefore, the ICM control unit also takes the steering angle of the rear wheels into account. Ultimately, the effective steering angle is calculated from the two steering angles (front and rear wheels).

The effective steering angle indicates the angle to which the front wheels would have to be turned to bring about the same vehicle response without steerable rear wheels.

That variable is the easiest for all vehicle systems to use to analyze the steering action.

Control and Modulation of Steering

Both the basic steering system and the optional Integrated Active Steering on the F01/F02 incorporate the Servotronic function. That speed-sensitive power assistance function is effected by way of the Servotronic valve on the steering gear.

The Servotronic valve is always controlled by the ICM control unit regardless of the equipment options fitted.

Accordingly, the Servotronic function algorithm is stored on the ICM control unit.

Similarly regardless of equipment options, the steering system also always incorporates a proportional control valve which is controlled by the ICM control unit. With the aid of that valve, the power steering pump's volumetric flow rate can be electronically adjusted.

For that reason it is also referred to as the "electronic volumetric flow control" valve (EVV valve).

That valve too is controlled by the ICM control unit.

Depending on the degree of power assistance demanded at the time, the volumetric flow rate delivered by the power steering pump is split between the steering valve and a bypass circuit.

The ratio of that split can be infinitely varied. The less power assistance is required, the more hydraulic fluid is diverted into the bypass circuit. As the hydraulic fluid does not have to do any work in the bypass circuit, less power is required to drive the power steering pump.

Consequently, the proportional control valve helps to reduce fuel consumption and CO2 emissions.

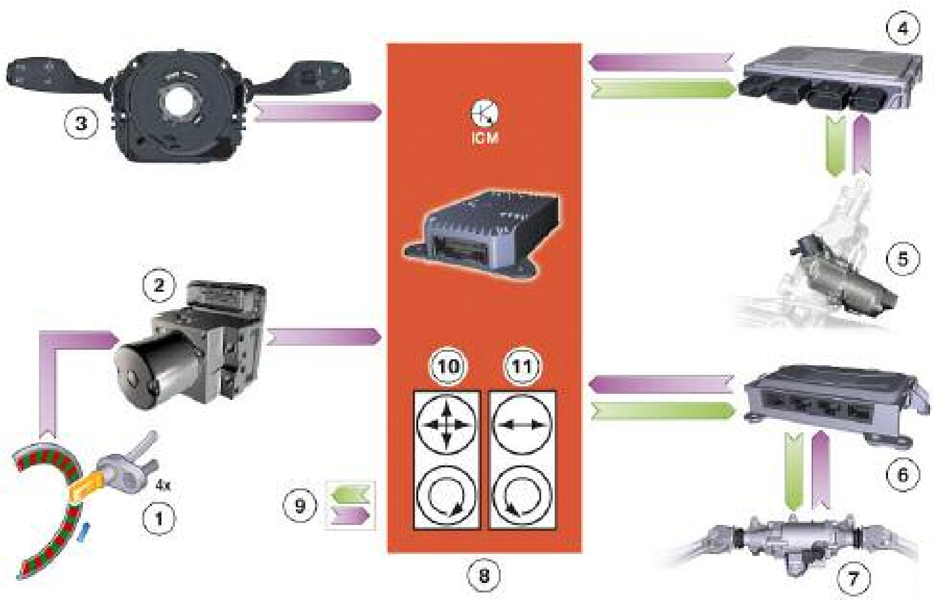
Distributed Functions

ICM and actuator control units The distribution of functions between the ICM and the other dynamic handling control units in the case of Integrated Active Steering is described below.

The Integrated Chassis Management is the control unit which computes the higher-level dynamic handling control functions for the Integrated Active Steering.

From the current vehicle handling status and the desired course indicated by the driver, the Integrated Chassis Management calculates individual settings for the variable steering gear ratio and the superimposed yaw rate.

Once they have been prioritized, the ICM provides a required setting in each case for the AL and HSR control units. The setting specified is a required steering angle to be applied to the front and rear wheels respectively.



Index	Explanation	Index	Explanation
1	Wheel speed sensors	7	HSR actuating unit
2	Dynamic Stability Control (DSC)	8	ICM
3	SZL (with steering angle sensor)	9	Input and Output signals (other)
4	Active Steering control module	10	Integrated DSC sensor linear, lateral acceleration and yaw rate
5	Active Steering Actuating Unit	11	Integrated DSC sensor lateral acceleration and yaw rate
6	HSR control module	12	

The AL control unit receives the required setting and has the main job of controlling the actuators so as to correctly apply the specified setting. Thus, the AL Active Steering control unit is purely an actuator control unit.

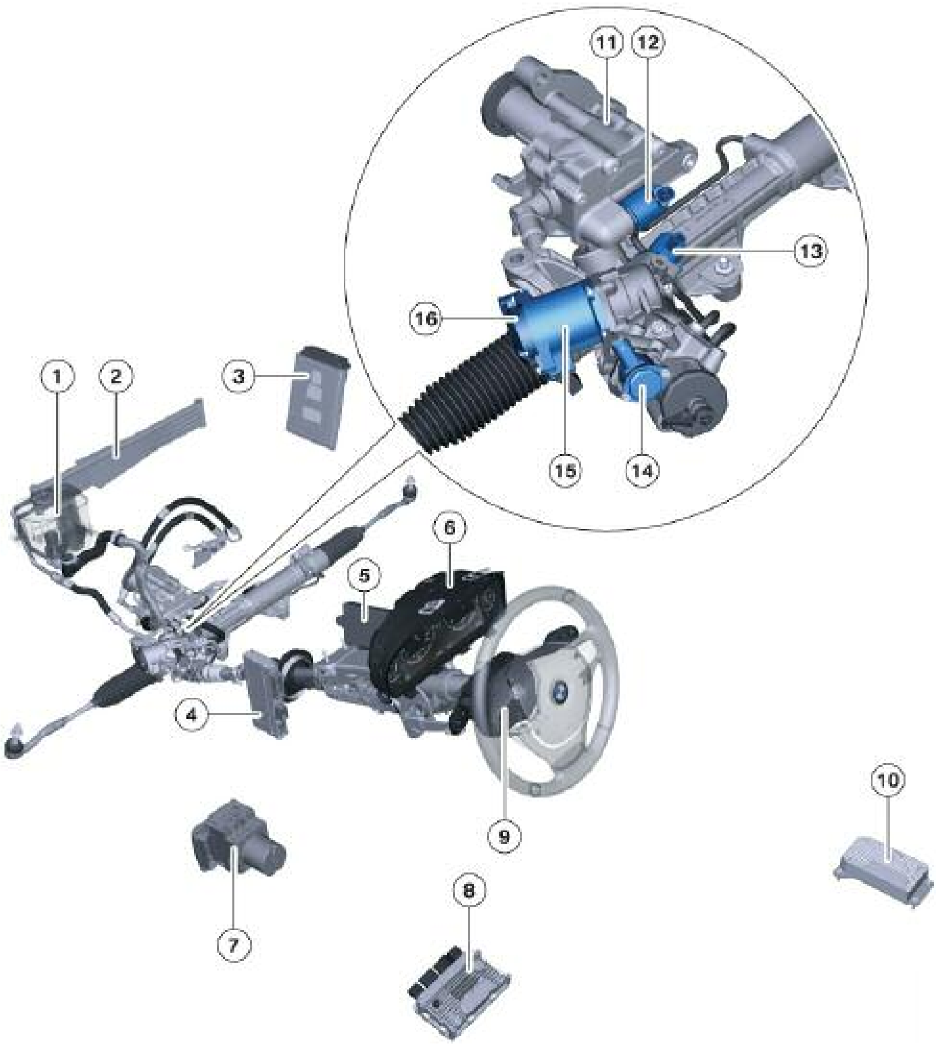
The same applies to the HSR control unit. It too is an actuator control unit. Like the AL control unit, it is responsible only for implementing the required steering angle specified by the ICM.

With the introduction of the ICM on the E71, this type of function distribution was used for the first time. On the F01/F02, it has been expanded to the extent that

- the ICM now controls all linear and lateral dynamics systems (AL, HSR and also DSC) and
- the ICM is the master control module both for linear dynamics and unstable handling situations.

The interface between the Integrated Chassis Management and the Dynamic Stability Control (DSC) represents a special case.

Components of Integrated Active Steering



Components and system complex for Active Steering (front)

Index	Explanation	Index	Explanation
1	Hydraulic fluid reservoir	9	SZL
2	Power steering cooler	10	ICM
3	DME	11	Hydraulic pump
4	ZGM	12	Electronic volumetric flow control (EVV) valve
5	CAS	13	Lock
6	Instrument cluster	14	Servotronic valve
7	DSC	15	Actuator unit electric motor
8	AL	16	Motor angular position sensor

Rear Axle Steering Control

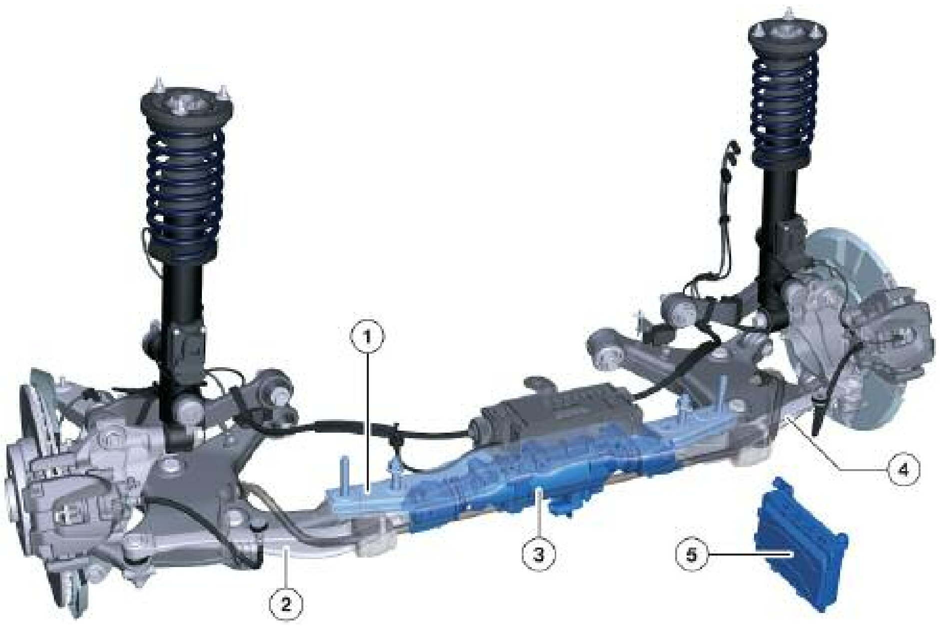
The special actuator on the rear suspension is fixed underneath a mounting plate on the rear suspension subframe.

The electro-mechanical actuator is positioned between the two new track rods of the Integral V rear suspension. The rear-wheel steering system has its own actuator control unit which is responsible for controlling and monitoring the actuator.

It was previously the state of the art that control systems were largely independent of one another.

On the F01/F02, the Integrated Chassis Management (ICM) system brings the separate systems together.

A central ICM control unit in the ICM architecture replaces the previous dynamic handling sensors and forms a central dynamic handling controller.

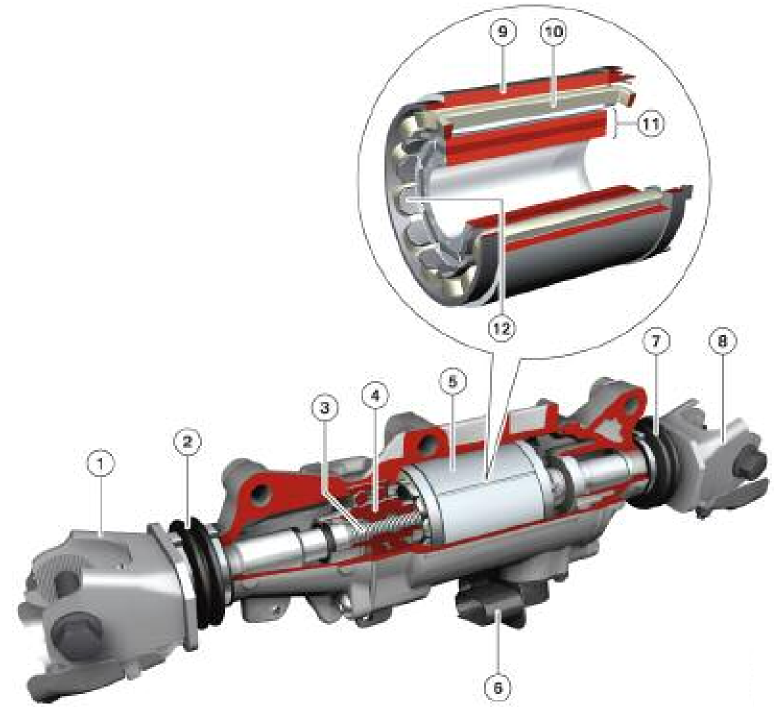


Index	Explanation	Index	Explanation
1	Mounting plate	4	Right track rod
2	Left track rod	5	HSR control module
3	HSR actuator		

The electromechanical actuator essentially consists of an electric motor which moves the two track rods by means of a worm-and-nut steering gear.

The actuator is designed for a maximum travel of ± 8 mm, which brings about a maximum steering angle of ± 3° at the wheels.

The worm-and-nut rear-wheel steering gear is self-inhibiting. That means that if the system fails, the vehicle adopts exactly the same handling characteristics as a vehicle without rear-wheel steering.



Index	Explanation	Index	Explanation
1	Left track rod joint	7	Right shaft bellows (gaiter)
2	Left shaft bellows (gaiter)	8	Right track rod joint
3	Worm shaft	9	Iron jacket
4	Worm nut	10	Stator windings
5	Electric motor	11	Permanent magnet
6	Electrical connector	12	Carrier armature winding iron core

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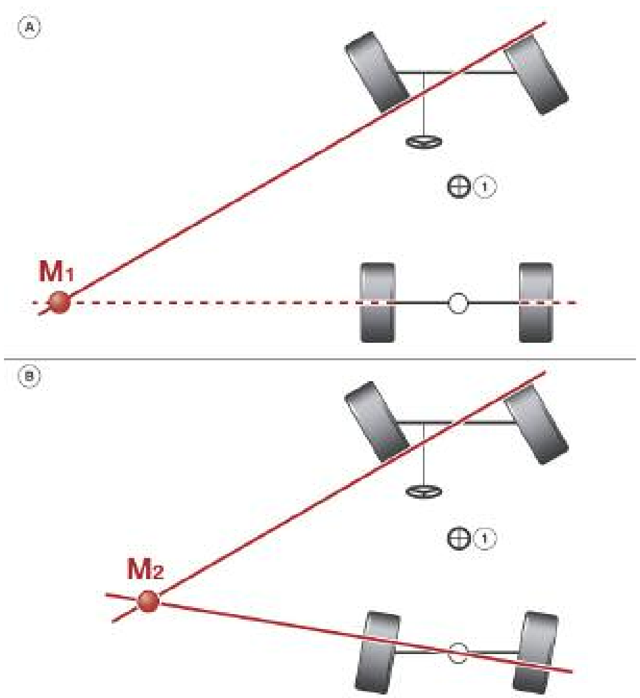
Functions of Integrated Active Steering

Low Speed Range

The variable steering-gear ratio of the Active Steering component reduces steering effort to approximately 2 turns of the steering wheel from lock to lock.

In the low speed range up to approximately 37 mph, the variable steering-gear ratio for the front wheels is combined with a degree of opposite rear-wheel steer. The effect is to increase the vehicle agility.



Index	Explanation	Index	Explanation
A	Conventional steering system	M2	Momentary axis 2
B	Integrated Active Steering	1	Vehicle center point
M1	Momentary axis 1		

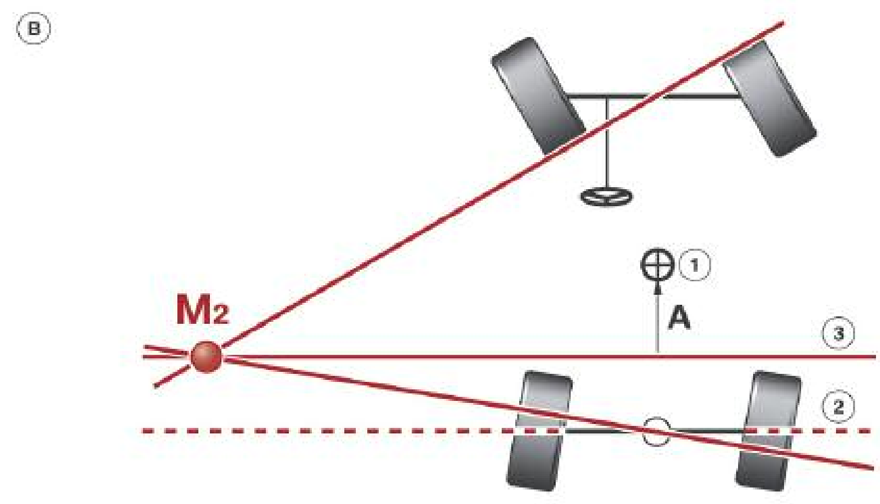
When the steering wheels of a vehicle are turned, it follows a curved path around what is called the momentary axis "M".

In the case of conventional vehicles, that momentary axis is positioned at a point along the extension of a line passing through the center of the rear wheels.

Active Steering intervention turns the rear wheels in the opposite direction at speeds up to approximately 37 mph.

The consequence of the rear-wheel steering intervention is that the axis of rotation moves closer to the center of the vehicle with the same amount of steering effort.

In terms of agility and dynamic handling, that is equivalent to a vehicle with a shorter wheelbase.

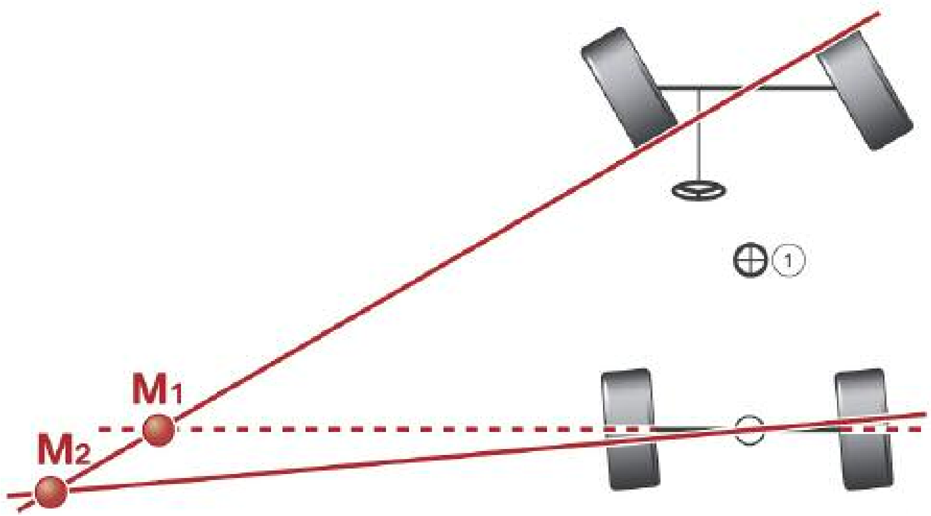


Index	Explanation	Index	Explanation
A	Conventional steering system	1	Vehicle center point
B	Integrated Active Steering	2	Straight line through center of rear wheels
M2	Momentary axis 2	3	Axis of rotation, closer to vehicle center

High Speed Range
As the vehicle speed increases, the degree of steering angle amplification by the Active Steering component is reduced. The steering gear ratio becomes less direct.

At the same time, the steering strategy adopted by the Integrated Active Steering changes. Whereas, at low speeds, the rear wheels are steered in the opposite direction to the front wheels, at higher speeds the rear wheels are steered in the same direction as the front.

The momentary axis moves further back, equivalent to a vehicle with a longer wheelbase, producing more stable straight line handling. The radius of the curve becomes longer.

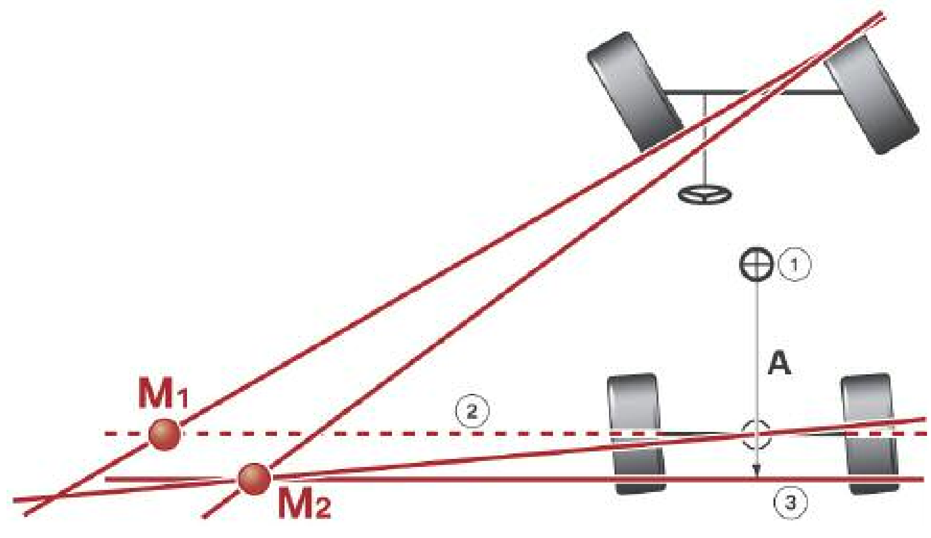


Index	Explanation	Index	Explanation
M1	Momentary axis 1	1	Vehicle center point
M2	Momentary axis 2		

By the combination with the Active Steering, an additional amount is added to the steering angle of the front wheels so that the radius of the curve and the required amount of steering lock remain at the familiar level.

All in all, co-ordination of the steering interventions at front and rear makes lane changes and steering maneuvers considerably easier to negotiate without sacrificing agility or balance.

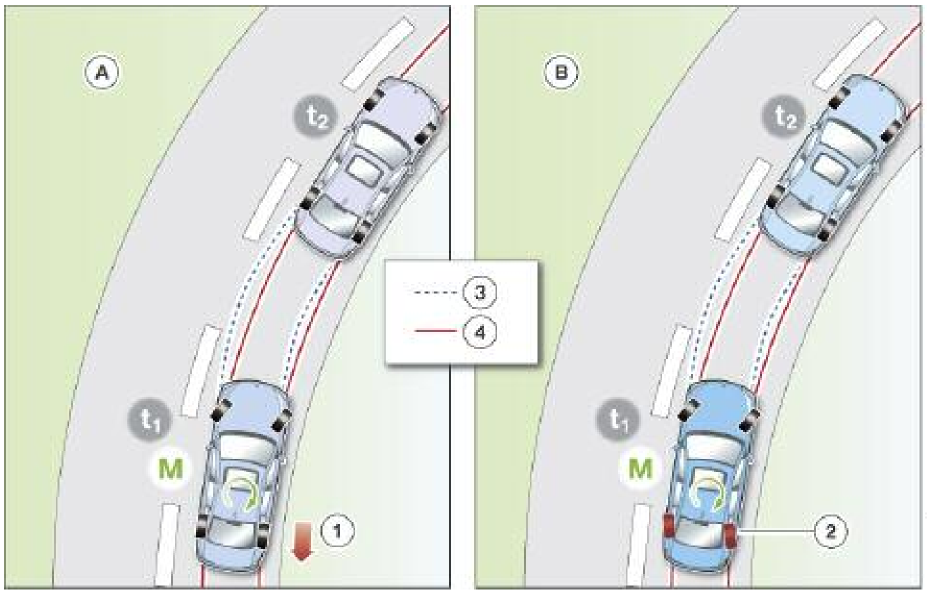
Combination of the Active Steering with the new rear-wheel steering system offers benefits for the driver at all speeds.



Index	Explanation	Index	Explanation
M1	Momentary axis 1	1	Vehicle center point
M2	Momentary axis 2	2	Straight line through center of rear wheels
A	Effective wheelbase increase	3	Axis of rotation further from vehicle center

Handling stabilization by IAL when understeering
When changing lanes quickly, all vehicles have a tendency to produce a significant yaw response and can sometimes start to oversteer.

If the ICM dynamic handling controller detects a difference between the response desired by the driver and the reaction of the vehicle, it initiates co-ordinated steering interventions on the front and rear wheels.



Index	Explanation
A	Prevention of understeer by individual brake modulation (DSC)
B	Prevention of understeer by rear-wheel steering intervention (IAL)
1	Individual brake modulation (DSC)
2	Rear-wheel steering intervention (IAL)
3	Course of an understeering vehicle
4	Course of a vehicle with neutral handling
M	Yaw force acting on the vehicle as a result of dynamic handling system intervention

The speed of the stabilizing intervention is such that it is hardly discernible by the driver. Braking interventions by the DSC, which have a decelerating effect, can be largely dispensed with.

The end result is that the vehicle is more stable and more effectively damped. If the driver underestimates how sharp a bend is when driving quickly on a country road, he/she can be caught out by sudden understeer.

By virtue of its inherent features, Active Steering was only able to react to vehicle oversteer. Integrated Active Steering incorporating active rear-wheel steering is now also able to make corrective interventions when the vehicle is oversteering and thus further increases active safety.

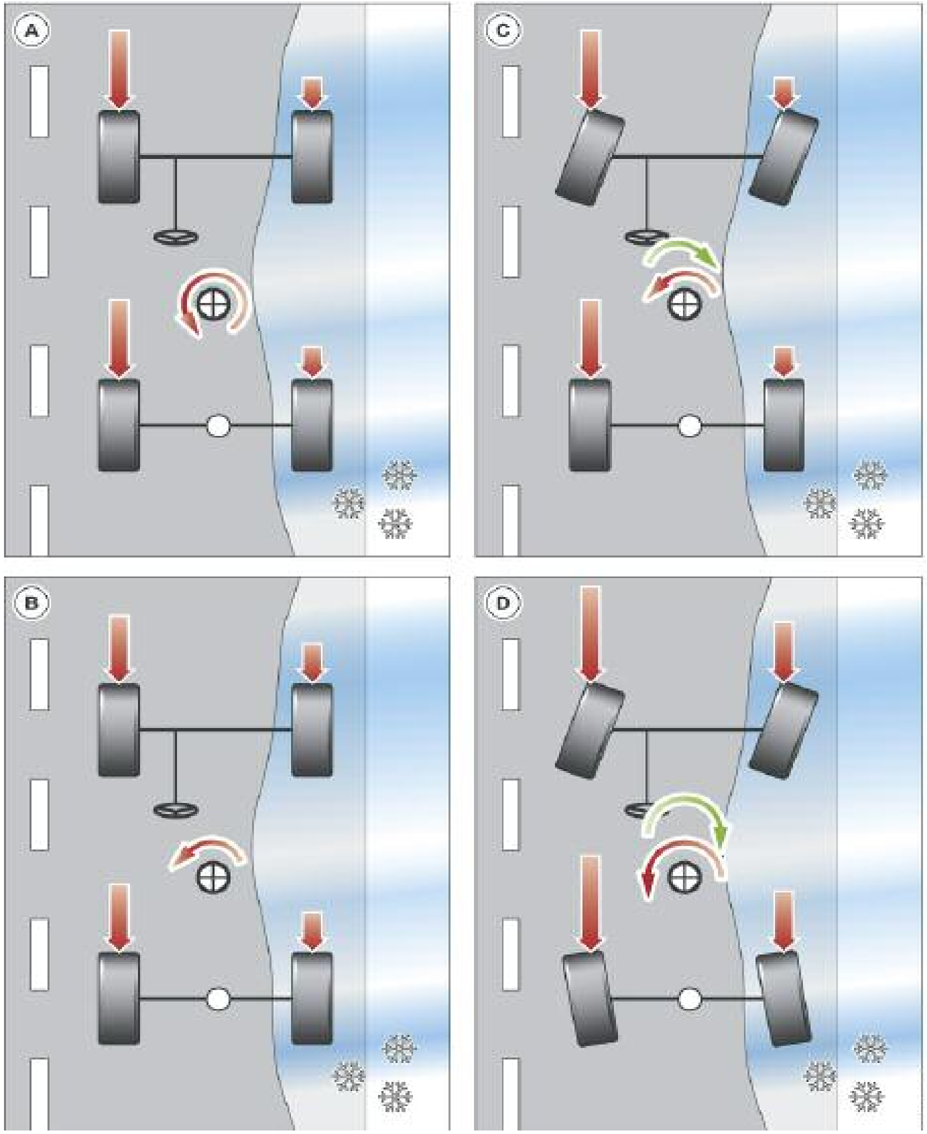
Handling stabilization by Integrated Active Steering under μ-split braking conditions
Hard braking on road surfaces which provide less grip for the wheels on one side of the vehicle than on the other causes the vehicle to yaw towards the side with more grip.

Under emergency braking, the driver of a conventional vehicle then has to correct the vehicle's course.

Under such μ-split braking conditions, the dynamic handling controller generates a stabilizing yaw force by opposite steering interventions on the front and rear wheels.

A) Without DSC
In the case of a vehicle without DSC, maximum braking effect is achieved by the wheels on the dry side of the road, while those on the wet or icy side produce very little retardation.

As a result, a very substantial yaw force acting in an counterclockwise direction is produced, causing the vehicle to swerve to the right.



Index	Explanation	Index	Explanation
A	Vehicle without DSC	C	Vehicle with DSC and AL (i.e. E90 w/yaw force compensation
B	Vehicle with DSC	D	Vehicle with DSC and IAL

B) With DSC
A vehicle equipped with DSC brakes the individual wheels more sensitively in order to keep the yaw force within manageable limits for the driver, which however, slightly increases the braking distance.

C) With DSC and AL
The additional "yaw force compensation" function represents a significant safety feature.

When braking on road surfaces with differences in frictional coefficient between one side of the vehicle and the other (tarmac, ice or snow), a turning force is generated around the vehicle's vertical axis (yaw force) rendering the vehicle unstable.

In such cases, the DSC calculates the required steering angle for the front wheels and the Active Steering implements it by actively applying opposite lock.

As a result, an opposing yaw force around the vertical axis is generated, "compensating" for the original yaw force (cancelling it out, i.e. the vehicle is stabilized by intelligent co-ordination of DSC brake modulation and AL steering, constituting a safety feature unique in this class of vehicle).

D) With DSC, dynamic handling controller and Integrated Active Steering
Under such µ-split braking conditions, the dynamic handling controller generates a stabilizing yaw force by opposite steering interventions on the front and rear wheels.

That counteracts the slowing of the vehicle caused by the uneven braking forces. At the same time, maximum braking force can be applied in order to achieve a short braking distance.

IAL is a logical development from the Active Steering systems. The functions of the systems complement each other perfectly, taking the driving experience to a new dimension.

Integrated Active Steering special function
Quite obviously, Active Steering systems must not be capable of being switched on or off by the driver.

In the case of Integrated Active Steering, there is a special feature in that regard because if snow chains are fitted to the rear wheels, Active Steering of the rear wheels must be disabled.

When snow chains are fitted, the rear-wheel steering is deactivated in order to ensure that the wheels are always free to rotate.

Automatic snow-chain detection assists the driver and indicates the detected status on the Control Display. This does not remove the responsibility for manually changing the setting.

When show chains are used, the setting on the iDrive Settings menu must be changed to "Show chains fitted".

If the maximum speed of 30 mph for driving with snow chains is exceeded, the rear-wheel steering is reactivated regardless of the "Snow chains fitted" setting.

Automatic snow chain detection
It is possible to detect from the wheel-speed sensor signals a characteristic pattern produced by the motion of the wheel when show chains are fitted (only with BMW approved show chains). From that characteristics signal pattern, the control unit is able to detect whether show chains are fitted on each individual wheel.

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Classroom Exercise - Review Questions

1. Which control module contains the output stages for the EVV and Servotronic solenoid? (circle one)

   ICM VDM ACSM DSC

2. On an F01 with IAL, what happens to the rear wheels when braking on a split frictional surface (i.e. right wheels on ice, left wheels on dry ground)?

3. How are the snow chains "automatically" detected? And, what is the maximum speed for driving with snow chains before the rear steering is re-activated?

4. On an F01 with IAL, what happens to the rear wheels when the vehicle is "understeering" on a turn?

5. What is the maximum travel of the HSR actuator? And, what is the maximum change of the steering angle at the rear wheels?

6. How is the HSR actuator connected to the HSR control module? (bus,hardwire)

7. Two technicians are discussing the active steering systems on the F01/02.

   Technician A says that the Active (front) Steering can be ordered independently of the option for rear wheel steering.

   Technician B says that both systems are optional, but can only be ordered together as part of the IAL system in the "Sport Package".

   Who is correct?

   A. Technician A B. Technician B
   C. Both A and B D. Neither

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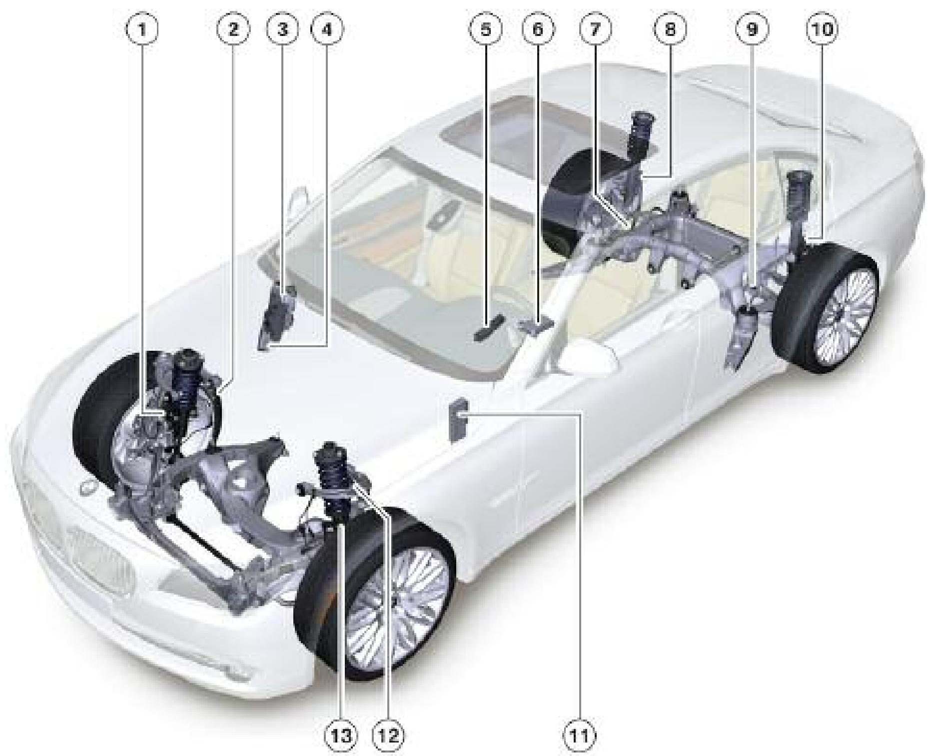
Vertical Dynamics Systems

The following systems are available on the F01/F02:

- Vertical Dynamics Control 2 (VDC II)
- Active Roll Stabilization (ARS)
- Electronic ride-height control (EHC)

VDC II is fitted as standard on the F01/F02. ARS is an option on the F01and F02, whereas EHC is standard on the F02.

Vertical Dynamics Control



Index	Explanation	Index	Explanation
1	EDC, SVR	8	EDC, SHR
2	Ride-height sensor, front right	9	Ride height sensor, rear left
3	Front power distribution box	10	EDC, SHL
4	VDM	11	ZGM
5	Driving Dynamics switch	12	Ride height sensor, front left
6	ICM	13	EDC, SVL
7	Ride height sensor, rear right		

When driven vigorously or on an uneven road surface, a vehicle tends to respond with undesirable body movements. BMW first developed Vertical Dynamics Control for the E70 and was able to effectively reduce such body motion as a result.

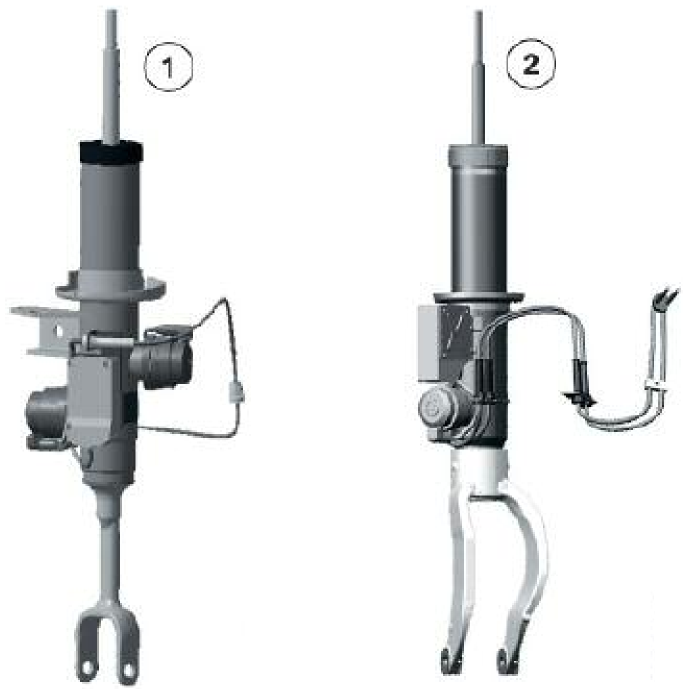
VDC improves the following driver-perception related vehicle characteristics according to road surface conditions:

- Body-related ride comfort (primary ride comfort)
- Road wheel-related ride comfort (secondary ride comfort)
- Dynamic handling (transitional response, agility) even with more comfortable suspension setting.

BMW is the first manufacturer to offer a damper adjustment system that is continuously controllable independently of damper compression/extension as is the case with the VDC (2) on the F01/F02.

The essential improvements compared with VDC (1) are:

- 2 EDC control valves per damper, 1 for damper extension control and 1 for damper compression control
- "Pre-opening adjustment" for improved body stabilization (has adjustment effect even at low damper rates)
- Driver-perceptible broad spread in conjunction with the driving dynamics switch (difference between soft and hard characteristics)
- Separately adjustable characteristic for road wheel-related ride comfort (extension characteristic independent of compression characteristic)



Index	Explanation	Index	Explanation
1	Front damper, VDC 2	2	Front damper, VDC 1

	VDC 1	VDC 2
Model	On E70/E71 included in Adaptive Drive Equipment package	Standard equipment in F01/F02
Program selection	Sport button next to gear selector	Handling setting switch next to gear selector
Program type	Sport/Comfort	Coordinated integration in all dynamic handling control functions
Control unit	VDM control module, right rear of luggage compartment 4 EDC satellite control modules directly on damper units	VDM control module, front right A-pillar 4 EDC satellite control modules directly on damper units
Damper	Twin tube, gas filled shock absorbers	Twin tube, gas filled shock absorbers
Fault diagnosis	VDM and EDC satellite control modules fully diagnosable	VDM and EDC satellite control modules fully diagnosable
Programming	VDM and EDC satellite control modules flash-programmable	VDM and EDC satellite control modules flash-programmable
Coding	VDM and EDC satellite control modules codable	VDM and EDC satellite control modules codable
Malfunction display	Messages in the Control Display or instrument cluster	Messages in the Control Display or instrument cluster
Testing	BMW diagnostic systems	BMW diagnostic systems

Signal Processing

- The vertical movement of the wheels is detected by the wheel-acceleration sensors integrated in the EDC satellite control modules.
- From the wheel acceleration rates and the ride height signals (FlexRay bus) the vehicle body motion is calculated.
- In addition, signals such as the vehicle road speed are read from the FlexRay bus for the purpose of determining required damping forces.

Signal Processing/VDC (2) Controller

Individual damping forces are calculated for each individual wheel according to the vehicle body motion, the wheel motion and the additional signals read from the FlexRay bus, and are sent every 2.5 ms to the EDC satellite control units.

Damping Force Adjustment

- Stored on each EDC satellite control unit is the actual individual damper characteristic, making it possible to minimize differences from the specified characteristic arising from manufacturing tolerances.
- From the specified damping force and the damper characteristic data-map, the EDC satellite control units calculate the required current to be applied to the damper extension valve and compression valve.

VDC System Components

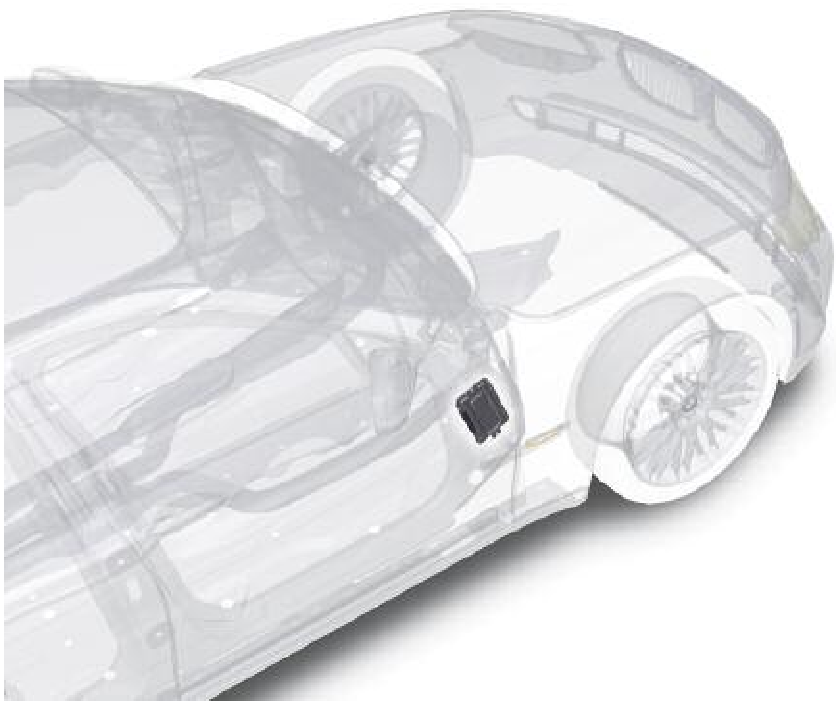
VDM Control Module

The location of the VDM control unit is located near the right hand A-pillar as previously mentioned on page 20.

There are two different versions of the VDM control unit according to the equipment options fitted on the vehicle:

- The basic version of the VDM control unit is used if the vehicle has only the standard VDC equipment
- The "high" version of the VDM control unit is used if, as well as the standard VDC system, the vehicle also has ARS Active Roll Stabilization (Dynamic Drive).

In that case, the output stages for controlling the ARS valve manifold are also integrated in the VDM control unit.



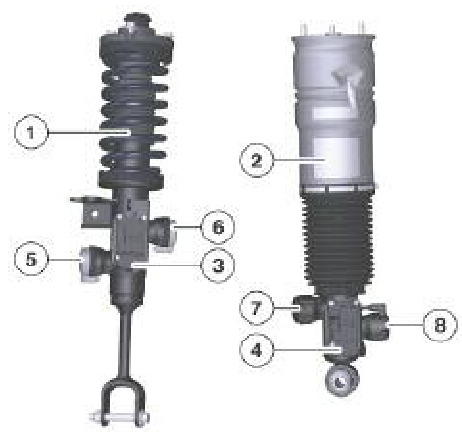
Ride Height Sensors

All F01 and F02 vehicles have ride height sensors. The sensors are direct hardwired input to the ICM.

More information for the ride height sensors can be found on page 27 in this workbook or in the reference material on ICP.

EDC Satellite with Damper

The VDC dampers on the rear suspension are either steel-spring or air-spring versions depending on the optional equipment fitted.



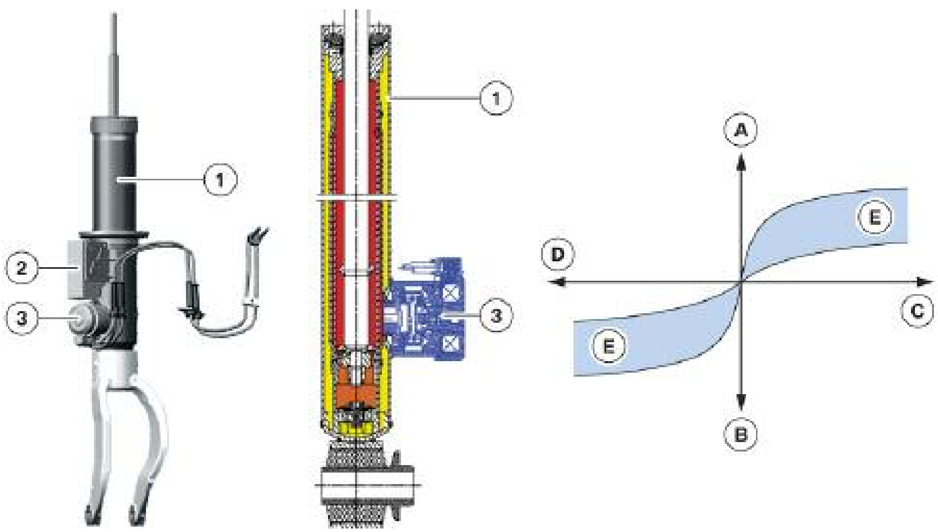
Index	Explanation
1	VDC Damper with steel spring
2	VDC damper with air spring
3	Front EDC satellite module
4	Rear EDC satellite module
5	EDC data-map valve for compression control
6	EDC data-map valve for extension control
7	EDC data-map valve for extension control
8	EDC data-map valve for compression control

VDC II Damper Operation

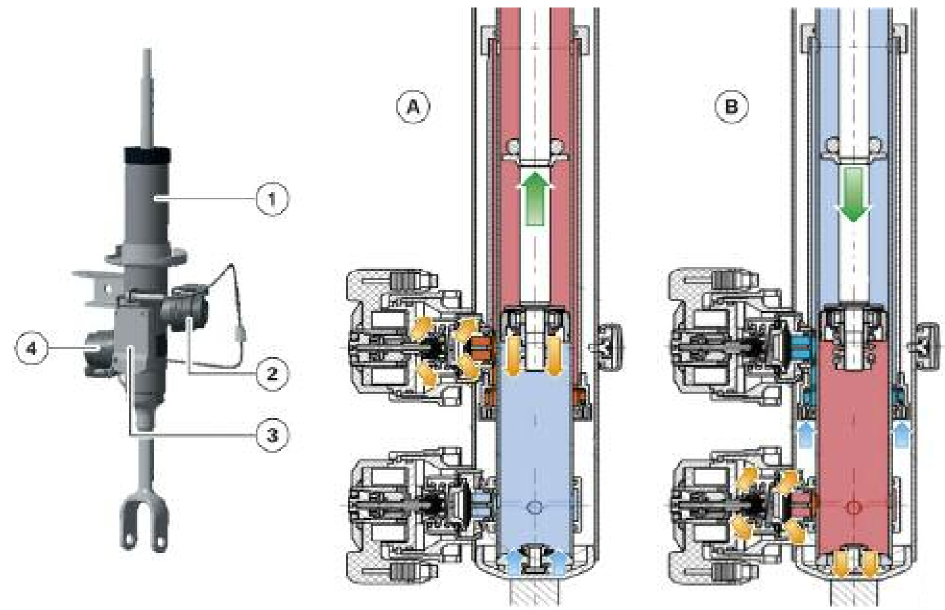
Comparison of VDC 1 to VDC 2 Damper

A VDC (1) damper with only one EDC data-map valve uses combined extension/compression adjustment which has to be cycled extremely rapidly.

With this type of control, the damper adjustment is based on wheel frequency. The wheel frequency is the frequency at which the wheel oscillates along the z-axis (vertically).



Index	Explanation	Index	Explanation
1	Damper tube	B	FC = Compression force
2	EDC satellite control unit	C	VE = Extension velocity
3	EDC data-map valve for extension and compression control	D	VC = Compression velocity
A	FE = Extension force	E	Extension and compression characteristic data-map

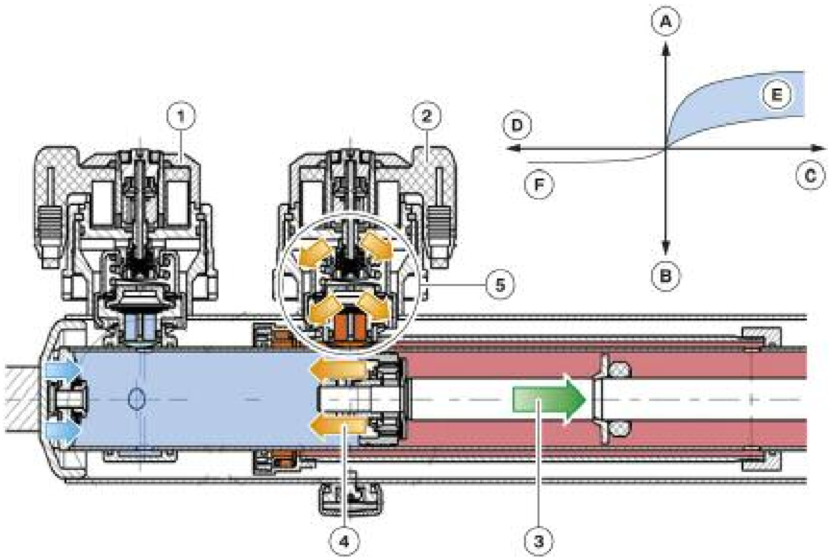


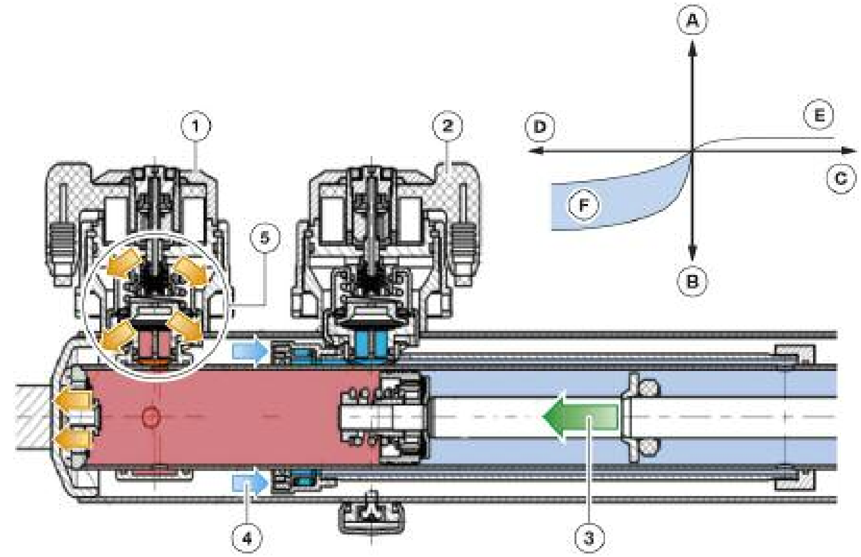
Index	Explanation	Index	Explanation
A	Extension progression	2	EDC data-map valve for extension
B	Compression progression	3	EDC satellite control unit
1	Damper tube	4	EDC data-map valve for compression

A VDC (2) damper with two EDC data-map valves uses independent extension/compression adjustment which does not demand such a high cycling rate.

With this type of control, the damper adjustment can be based on body frequency. The body frequency is the frequency at which the body oscillates along the z-axis (vertically).

The two EDC data-map valves firstly enable independent extension control and, therefore, data-map compatible design, and secondly independent compression control and, therefore, data-map compatible design.





Index	Explanation	Index	Explanation
1	EDC data-map valve for compression	B	FC = Compression force
2	EDC data-map valve for extension	C	VE = Extension velocity
3	Force/direction of piston rod movement	D	VC = Compression velocity
4	Fluid medium	E	Extension data-map
5	Data-map control	F	Compression data-map
A	FE = Extension force		

Control Strategy

The fundamental control principle is known as the "Skyhook system", which means, in theory, primary control objective of holding the vehicle stationary in a vertical direction regardless of driving situation as if suspended from a "hook in the sky".

To achieve this highest of all comfort objectives, the movements of the entire body have to be evaluated. Thus an overall analysis is performed of the ride height data and z-axis acceleration rates.

Furthermore, VDC regulation takes into consideration steering inputs based on the steering angle curve. If VDC detects a rapid increase in the steering angle, the driving dynamics control function infers that the vehicle is entering a bend and can preventively adjust the dampers on the outside of the bend to a harder setting in advance.

Thus VDC assists the ARS system, if fitted, and contributes to reducing vehicle roll (roll tendency).

Moreover, VDC is able to detect the braking operations by the driver based on the brake pressure information supplied by DSC. A high brake pressure normally results in pitching of the vehicle body; VDC counteracts that effect by setting the front dampers to higher damping forces. This also results in an improvement in the front/rear brake force distribution, which in turn reduces the braking distance (by comparison with a vehicle without VDC).

With the introduction of the handling setting switch, the VDC setting is incorporated in a number of modes which bring about a coordinated overall setting across all systems.

Active Roll Stabilization (ARS)

Active Roll Stabilization was first fitted on the 7 Series predecessor, the E65/E66, and has been used in similar form since on the E6x and E7x models.

This section only describes the essential details and modifications of the ARS on the F01/F02.

As Vertical Dynamics Control (VDC) is fitted as standard on the F01/F02, the ARS is now an option.

In customer communications, ARS continues to be marketed under the name "Dynamic Drive" on the F01/F02.

Vertical Dynamics Control

VDC and ARS have to respond with the appropriate speed in the event of rapid lane changes, rapid cornering or rapid changes of direction on winding country roads.

Overview of ARS Components

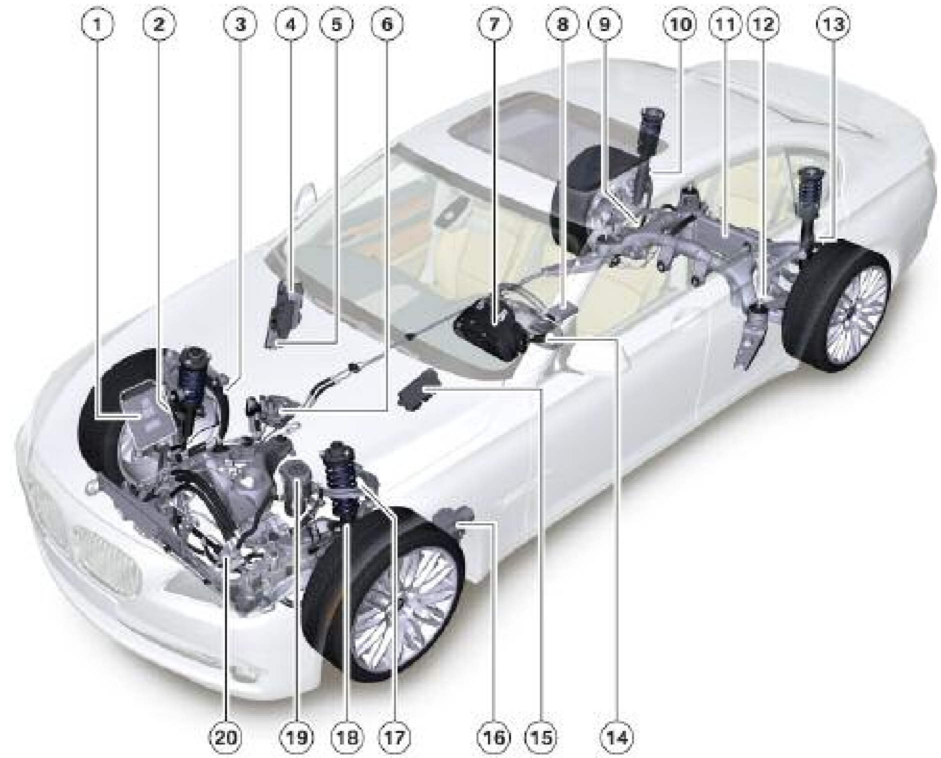
The components of the ARS system of the F01 are much the same as on past ARS systems.

The ARS control module is no longer used, the control of the ARS system (via ARS valve block) has been assumed by the VDM module.

VDM Module

The VDM module contains the appropriate output stages for controlling the ARS valve block. The system architecture on the F01/F02 now features two different versions of the VDM control module:

- If ARS is **not** fitted, the VDM has **no** output stages for ARS valve manifold control
- If ARS is fitted, the VDM has output stages for ARS valve manifold control



Index	Explanation	Index	Explanation
1	DME	11	Rear hydraulic motor
2	EDC, SVR	12	Ride height sensor
3	Ride height sensor	13	EDC, SHL
4	Front power distribution box	14	SZL
5	VDM	15	ZGM
6	ARS valve manifold	16	DSC
7	Instrument cluster	17	Ride height sensor
8	ICM	18	EDC, SVL
9	Ride height sensor	19	Hydraulic fluid reservoir
10	EDC, SHR	20	Front hydraulic motor

The VDM control module is located in the passenger compartment near the right-hand A-pillar. It receives its power supply via KL15N and is protected by a 5A fuse.

The VDM control unit is activated exclusively by the Car Access System (CAS) via a Terminal 15N lead as of status "Ignition ON".

A vehicle authentication process takes place when the system is started.

All outputs (valve solenoids and sensors) are subjected to a comprehensive check for short circuits and circuit breaks. If there is a fault, the system switches the actuators to a safe-driving mode.

The VDM control unit switches off if the voltage is too low/too high.

VDM Control Unit Inputs

From the input signals, the VDM control unit calculates the control signals to the actuators. The input signals are also checked for plausibility and used for system monitoring.

The VDM control unit receives the following input signals:

- FlexRay bus
- Front-suspension circuit pressure (analog)
- Rear-suspension circuit pressure (analog)
- Switch position detector reading (analog)
- Fluid level sensor signal (analog)

The most important control signal for the ARS function is the lateral acceleration measured by the ICM control unit, which is sent to the VDM via the FlexRay bus. Additional lateral dynamics information from the FlexRay bus which is also provided by the ICM comprises the road speed signal and the steering angle.

From that, the stabilization requirement is calculated and the relevant active forces are applied. The road speed and steering angle information is also used to improve the reaction time of the system.

VDM Control Unit Outputs

All outputs are compatible with diagnostics and protected against short-circuit. The outputs include controls for:

- Pressure regulating valves for front and rear axle
- Failsafe valve
- Directional valve
- Intake restrictor valve
- 5 V power supply for the sensors:
  - Pressure sensors at the front and rear axle
  - Switch-position detector (SSE)

The valves are controlled by the supply of current regulated by pulse-width modulation (PWM).

The valve currents are mutually checked for plausibility on a continuous basis. Therefore, the pressure can be set more precisely and the switch valves can be monitored electronically.

Fault symptoms of the output signals are:

- Short circuit to Terminal 30 and Terminal
- Open circuit and
- Valve short circuits
- Sensor power supply faults

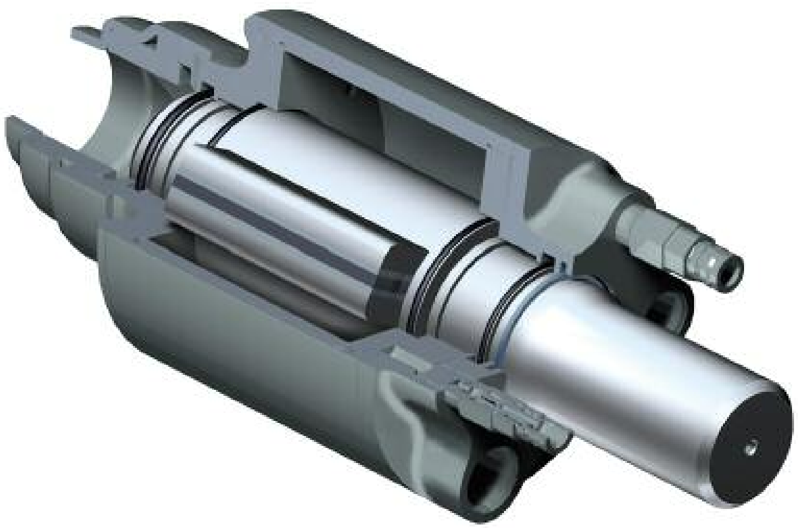
A message is sent to the DME via the FlexRay bus from the central dynamic handling controller on the ICM. The message contains information on how much power the tandem pump currently requires to supply the active anti-roll bars.

In this way, output at the engine can be increased to satisfy the additional power requirement. A regular data signal (alive signal) is broadcast and read by other VDM control units to identify whether the system is still active. In addition, a function status signal is broadcast which communicates the status of the ARS function.

The VDM control unit transmits an additional status message via the FlexRay to the instrument cluster in order to actively initiate display messages. That status message is assigned a priority among all suspension/steering messages by the message coordinator on the ICM control unit and passed to the instrument cluster.

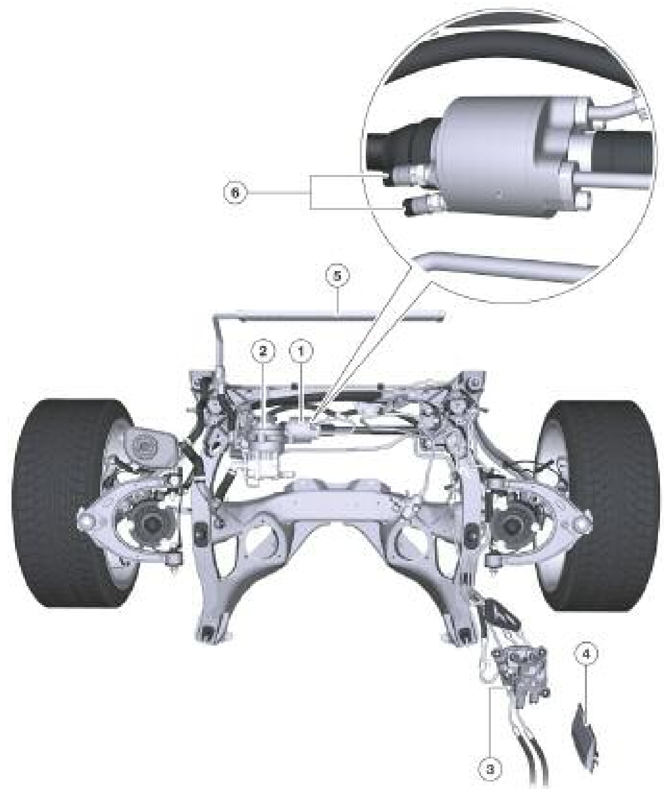
All signal faults are recorded and permanently stored in the fault memory. If the alive signal fails, the ICM control unit automatically sends a message to the instrument cluster to activate the ARS warning lamp.

Oscillating Motor
The hydraulic motor and the hydraulic motor body are each attached to one half of the anti-roll bar. The active anti-roll bar consists of the oscillating motor and the anti-roll bar halves fitted to the oscillating motor, with press-fitted roller bearings for their connection to the axle carriers. The use of roller bearings ensures optimum comfort thanks to better response and reduced control forces. A thin coating of grease on the roller bearing does not impair the function of the active anti-roll bar.



Active Anti-roll Bar, front
The anti-roll bar is mounted on the front suspension subframe. The anti-roll bar links are attached to the pivot bearing. There are two pressure relief valves on the hydraulic motor of the front suspension anti-roll bar.

On the pressure relief valves there are air filter elements (black plastic caps) attached. Those black air filter caps with Goretex inserts must not be removed.

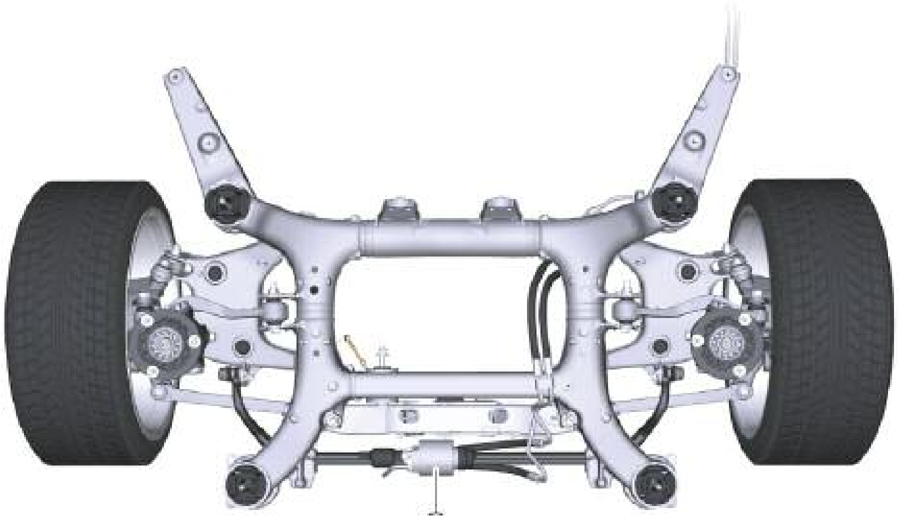


Index	Explanation	Index	Explanation
1	Oscillating motor	4	VDM
2	Tandem pump	5	Power steering cooler
3	ARS valve manifold	6	Air filter element

Rear Suspension Active Anti-roll Bar

The anti-roll bar is mounted behind the rear suspension subframe. The anti-roll bar links are attached to the rear suspension swing arms.

On the hydraulic motor for the rear suspension anti-roll bar, blanking plugs are fitted in place of the pressure relief valves.



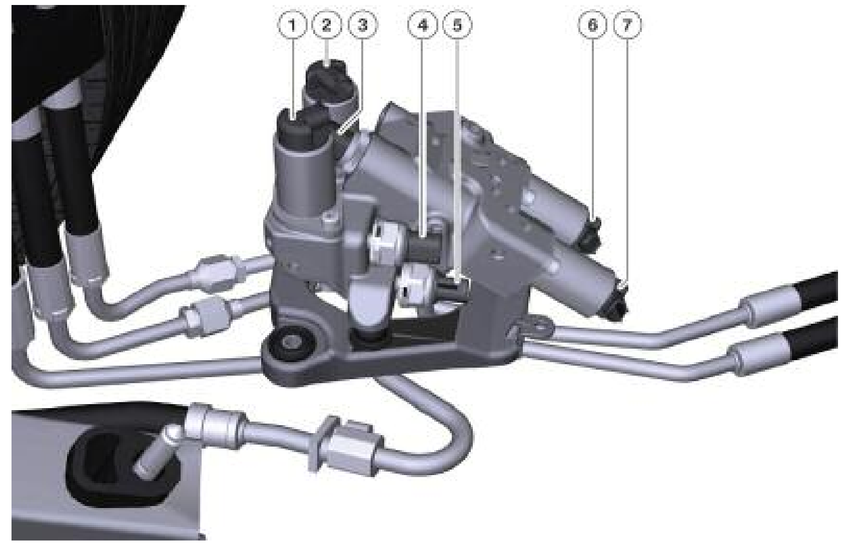
Index	Explanation
1	Rear suspension, oscillating motor (hydraulic)

ARS Hydraulic Valve Manifold

The hydraulic valve block is located on the floor plate of the vehicle behind the front right hand wheel housing level with the front right-hand door.

The hydraulic valve block is connected to a carrier plate bolted to the body. The hydraulic valve block houses the following valves and sensors:

- 2 pressure valves; 1 for the front suspension and 1 for the rear suspension [these are proportional pressure limiting valves]
- 1 directional control valve
- 1 failsafe valve
- 2 pressure sensors; 1 sensor for the front suspension, 1 sensor for the rear suspension
- Switch-position detector



Index	Explanation	Index	Explanation
1	Front axle, pressure valve (PVV)	5	Rear axle pressure sensor (DSH)
2	Rear axle, pressure valve (PVH)	6	Failsafe valve (FS)
3	Switch position detector (SSE)	7	Directional valve (RV)
4	Front axle pressure sensor (DSV)		

Tandem Pump

The hydraulic pumps fitted in this model series were based on a modular design principle. Depending on the engine and equipment specification, a suitably dimensioned hydraulic pump is flange-mounted to the engine in the same installation space. Decisive equipment features for these tandem pumps:

- Basic steering
- Integrated Active Steering (IAL)
- CO_2 reduction measures
- Dynamic Drive (ARS)
- Dynamic Drive (ARS) and Integrated Active Steering (IAL)
- Intake restrictor valve

Index	Explanation	Index	Explanation
1	Radial piston pump	3	Electronic volumetric flow control valve
2	Intake restrictor valve	4	Vane pump, power steering

The hydraulic pump driven by the engine's poly-V belt is, on vehicles with Dynamic Drive, invariably a tandem pump, which consists of a radial-piston pump section for ARS and a vane pump section for the power steering. Radial-piston pump section of the tandem pump:

Radial Piston Pump

This radial piston pump has 8 pistons in a single row and is designed for a maximum pressure of 210 bar.

When the engine is idling, the pump speed is approximately 750 rpm. At that speed, the radial piston pump section delivers a minimum fluid flow rate of approximately 5.5 liters per minute at a pressure of approximately 3 bar. Consequently an adequate fluid flow rate is guaranteed even at idling speed.

At a pump speed of 1450 rpm, the maximum fluid flow rate is limited to approximately 9 liters per minute.

New Feature

As a CO_2 reduction measure when driving in a straight line, the fluid flow rate of the radial piston pump is restricted by a restrictor valve on the intake side, thereby substantially reducing the circulation pressure and, therefore, the engine power used to drive the pump. As a result, active control of the intake restrictor valve makes a positive contribution to the CO_2 equation.

The Dynamic Drive and hydraulic power steering share a common fluid reservoir and fluid cooler.

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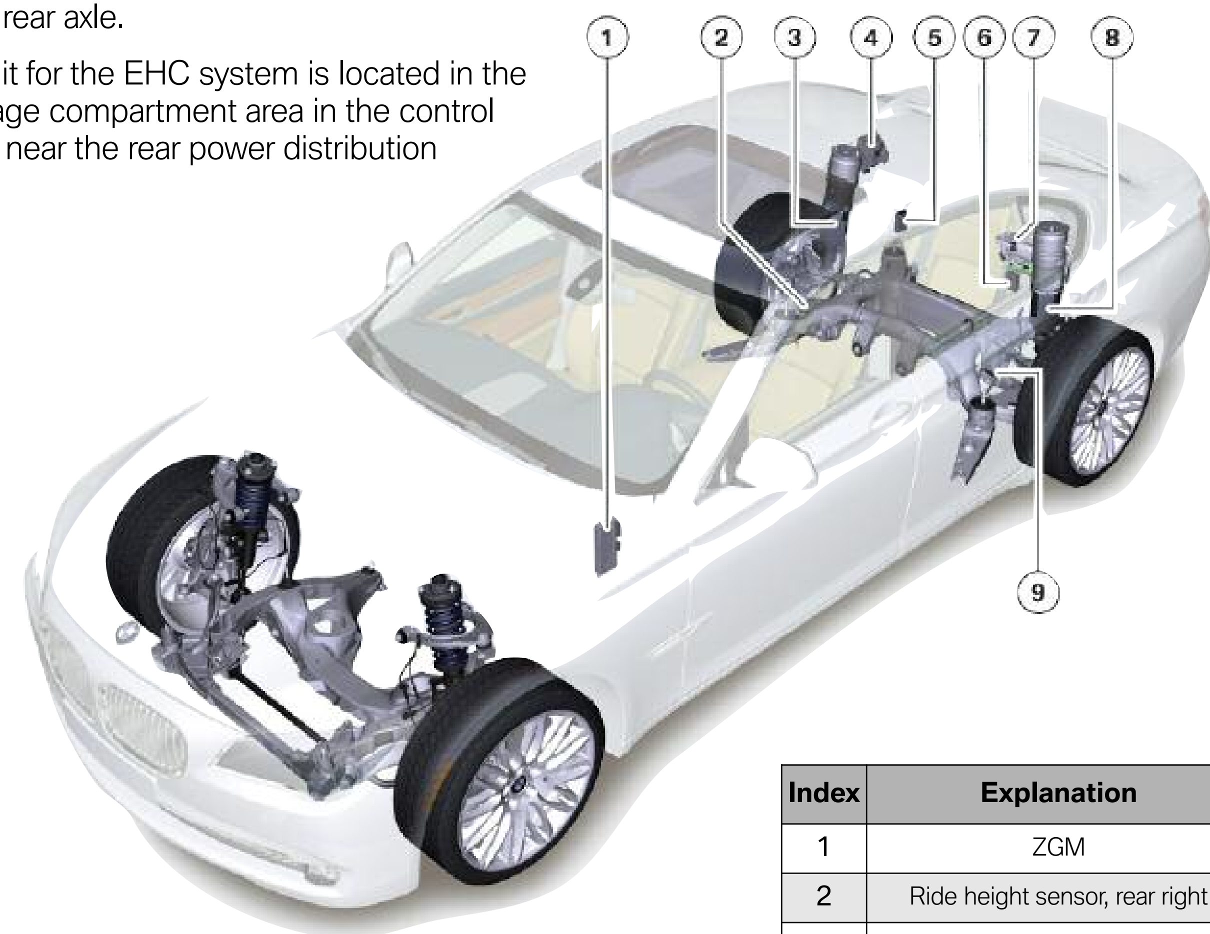
Electronic Ride Height Control (EHC)

As of the start of production, the EHC system is only available as standard equipment on the F02. At the time of vehicle launch, EHC is not available as an option on the F01.

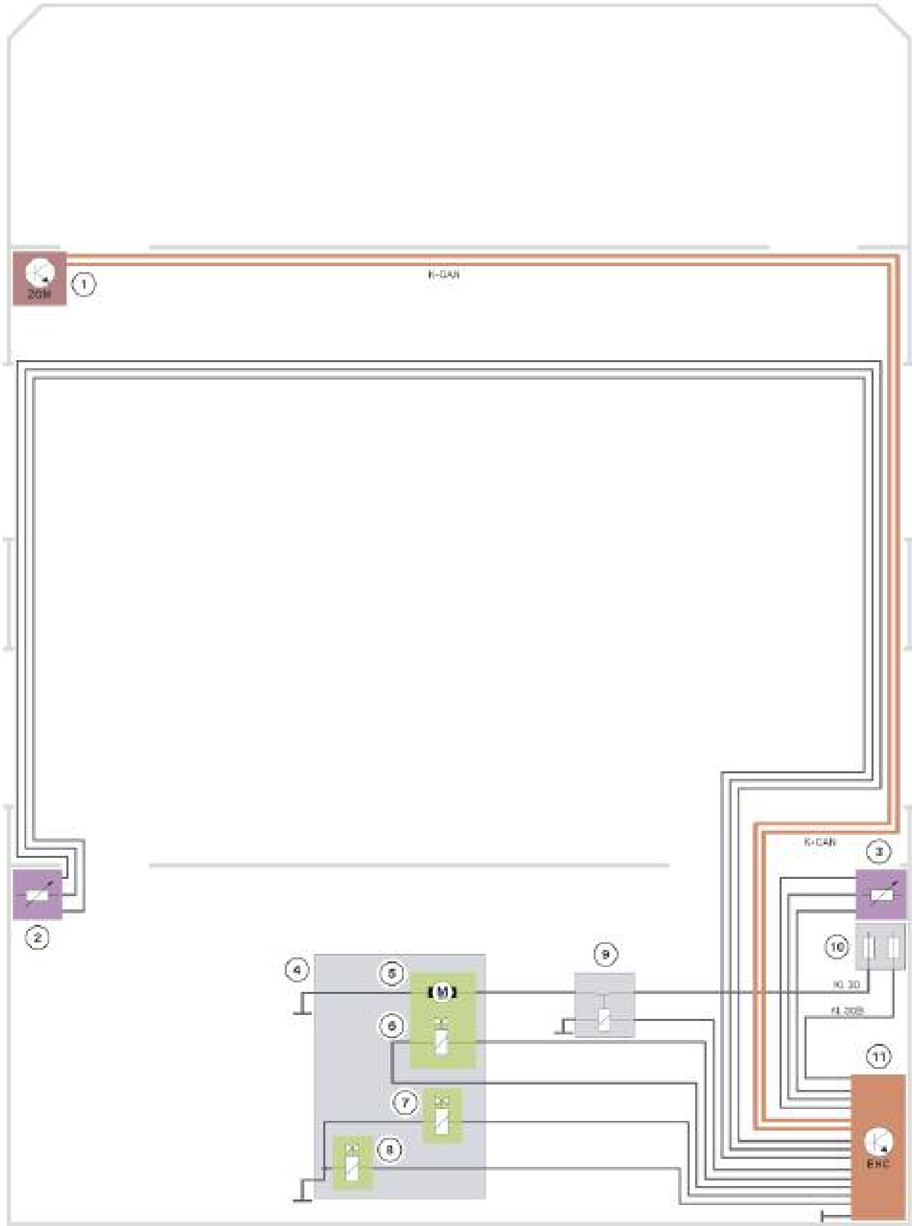
The EHC system operates much the same as previous EHC systems. On the F01, EHC is a “single-axle” air spring system for the rear axle.

The control unit for the EHC system is located in the right rear luggage compartment area in the control module carrier near the rear power distribution box.



Index	Explanation	Index	Explanation
1	ZGM	6	Air supply relay
2	Ride height sensor, rear right	7	Air Supply Unit (LVA)
3	EDC_SHR	8	EDC_SHL
4	Rear power distribution box	9	Ride height sensor, rear left
5	EHC control module		

EHC Circuit Diagram



Index	Explanation	Index	Explanation
1	ZGM	7	Solenoid valve, right side
2	Ride height sensor, rear left	8	Air exhaust valve
3	Ride height sensor, rear right	9	Air supply relay
4	Air Supply Unit (LVA)	10	Rear power distribution box
5	Compressor unit	11	EHC control module
6	Solenoid valve, left side		

Classroom Exercise - Review Questions

1. What are the primary functions of the VDM module?

2. What is different about the ride height sensors on a vehicle equipped with EHC?

3. Which portion of the tandem pump is responsible for providing pressure for the ARS system?

4. Why is it necessary for the VDM to receive brake pressure information from DSC?

5. What is unique about the damping control of the VDC system?

6. What is the purpose of the intake restrictor valve?

7. Where is the EHC module located on the F02?

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DCC and ACC

Trusted Driver Assistance Systems

BMW has long since offered a comprehensive range of driver assistance systems. These make it easier for the driver to control the vehicle, by:

- providing the driver with information,
- prompting the driver how to act or
- actively intervening in the way the vehicle is driven.

The systems in this section of the training workbook include:

- Cruise control with braking function (standard F01/F02)
- Active Cruise Control with Stop & Go function (opt)
- Adaptive Brake Assistant with warning function (w/ACC)

In the F01/F02, "Dynamic Cruise Control" (DCC) supersedes the cruise control (FGR) function available as standard in the E65.

The optional extra "Active Cruise Control with Stop & Go function" (ACC Stop & Go) provides optimum assistance to the driver not only in smoothly flowing traffic but also in traffic jam situations.

Both systems are based on the new architecture of the Integrated Chassis Management (ICM).

As part of the ACC with Stop & Go option, the F01/F02 features the Adaptive Brake Assistant function.

This safety function, has been supplemented by a new warning function in the F01/F02. It alerts the driver to a risk of collision detected by the long-range radar sensor. This enables the driver to intervene even faster and, potentially, to avoid an accident.

Dynamic Cruise Control

The cruise control with braking function was introduced with the BMW 3 Series (E9x). It is also referred to as "Dynamic Cruise Control" (DCC).

Mostly, DCC is a conventional cruise control system with some additional functions. The DCC offers the driver the opportunity to adjust the set speed in small or large increments, which is then set and maintained by the system by controlling power output and braking.

The brakes are also controlled during steep downhill driving if sufficient deceleration is not achieved by engine drag-torque alone.

Dynamic Cruise Control in the F01/F02 is not computed in the DSC control unit as it is in other vehicles. Instead, it has been integrated into the ICM control unit.

In the F01/F02, there are differences in how the function is operated and how information is displayed by comparison with the function implemented in other vehicles.

Operation and Display

In the F01/F02, Dynamic Cruise Control is no longer operated by means of an operating lever. Instead, the driver can operate the function conveniently using a button pad on the multifunction steering wheel.

To prevent accidental activation, the function remains inoperable until the I/0 button has been pressed after the vehicle has started, the DCC is then in standby.

This state is acknowledged in the instrument cluster by a green indicator light lighting up. With the function in standby, the driver is now able to activate cruise control. To do this, the driver can press the SET button used to store the vehicle's current road speed as the set speed.

An active state is indicated by a green indicator light in the circumference of the speedometer dial lighting up. There is an alternative way to activate the function if a set speed has already been stored.

This is indicated by an orange indicator light in the circumference of the speedometer dial. If the driver wants to use this speed value as the set speed, he simply has to press the RES button.

The DCC then accelerates or decelerates the vehicle to this speed value automatically. While the function is active, the driver is able to increase or decrease the set speed at any time. There are two adjustment increments available.

Index	Explanation
1	SET button to activate
2	Rocker switch to change the set speed
3	I/O button to switch on and off
4	RES button to resume to a set speed

The rocker switch offers two different incremental settings in either direction. First, the set speed is altered in increments of 1 mph each time the rocker switch is pressed; second, it is altered in increments of 5 mph.

In the F01/F02, the adjustment range for the set speed is 20 mph to 110 mph. If the rocker switch is pressed and held, the system will accelerate/decelerate the vehicle until the rocker switch is released. This is known as a "comfort dynamics" function as featured in the E9x and E6x LCI.

To deactivate the system, the driver can simply operate the brake pedal like before. Or, the driver can deactivate the system by pressing the I/0 button.

The system is then returned to standby and keeps the set speed last used stored in its memory. If the driver then presses the I/0 button once more, the system is completely switched off and the green indicator light in the instrument cluster goes out.

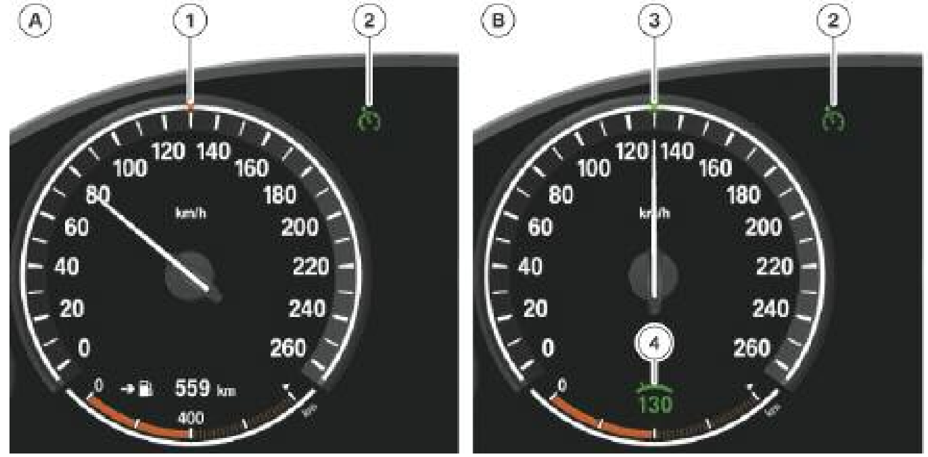
In the event of particular operating states, the displays shown here are supplemented by information messages displayed below the speedometer. This is the case, for instance, if the driver attempts to activate the system even though not all the activation criteria have been fulfilled (i.e. speed less than 20 mph).

In the F01/F02, a difference in the way Dynamic Stability Control interacts with Dynamic Cruise Control has been introduced.

This is explained by the following example: Using the "Driving Dynamics Switch", the driver has selected a mode in which DSC is inactive (e.g. "Sport+" mode). If the driver now activates cruise control, DSC will be activated automatically.

This is accompanied by an automatic changeover from Sport plus mode to "Normal" mode.

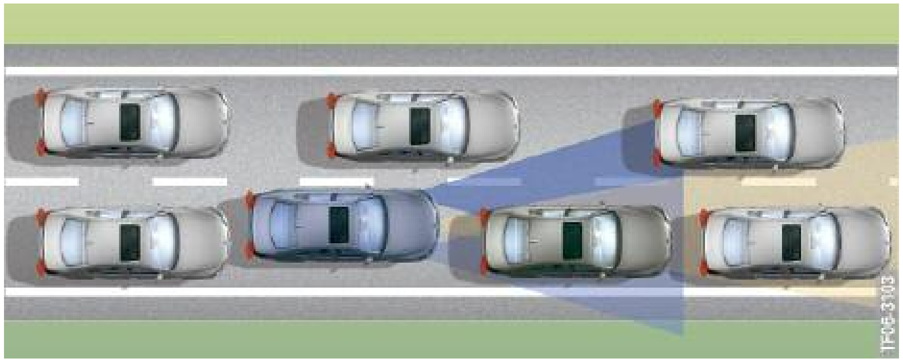
In previous vehicles, the driver was unable to activate cruise control without activating DSC manually first.



Index	Explanation
A	“Standby” indication
B	“Active” state
1	Orange LED: set speed of 130 km/h (80 mph) stored
2	Indicator light for DCC (DCC On)
3	Green LED; actively maintaining a set speed of 130 km/h (80 mph)
4	Set speed displayed numerically (briefly displayed at time of function activation or whenever the set speed is changed

Active Cruise Control with Stop & Go function

The ACC Stop & Go function in the F01/F02 is largely identical to that in the E6x LCI. ACC Stop & Go extends the operating range of the former ACC system to include low speeds down to a standstill.



In other words, speed and distance from the vehicle in front are automatically controlled at those speeds as well.

ACC Stop & Go will automatically stop the car if necessary and then indicate to the driver as soon as it detects that it is possible to start moving again.

To pull away again, the driver has to acknowledge this message. The pulling-away process is controlled fully automatically by ACC Stop & Go only if the duration of the standstill is very short.

Thus, ACC Stop & Go provides optimum assistance for the driver not only in moving traffic but also in traffic jams such as are more and more frequently encountered on highways. However, this system (in common with ACC) is not intended for use in urban areas for negotiating junctions or traffic lights.

The functions of ACC Stop & Go in the F01/F02 differ from those in the E6x LCI in the following areas:

- Operation and display
- Behavior in response to driver's intention to get out.

Operation and Display

ACC Stop & Go and DCC are activated/deactivated in a very similar way. The driver is able to activate ACC Stop & Go not only while the vehicle is in motion, but also when the vehicle is stationary, provided the system has detected another vehicle in front.

To activate ACC Stop & Go at a standstill, the driver has to depress the brake pedal and press the SET or RES button at the same time. The activation conditions that applied to the E6x LCI similarly apply here:

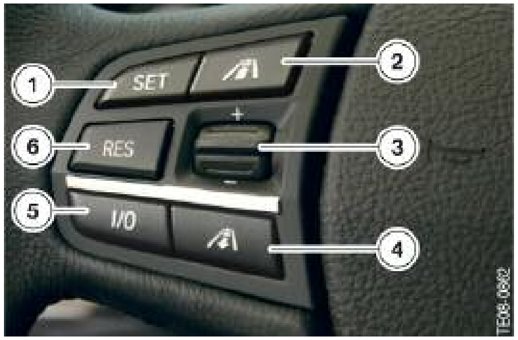
- Brake pedal must not be depressed
- Automatic transmission must be in Drive
- Parking brake must not be activated
- Radar sensors must be operational and not dirty
- There must be no system fault present.

If DSC was inactive before, in the F01/F02 it is activated as soon as ACC Stop & Go is activated. At the same time, the "Driving Dynamics Control" automatically changes to "Normal" mode (same behavior as for DCC).

Similarly, ACC Stop & Go cannot be deactivated by means of the I/0 button while the vehicle is stationary unless the brake pedal is depressed at the same time.

In the F01/F02, the adjustment range for the set speed is 20 mph to 110 mph as it is in the E6x LCI.

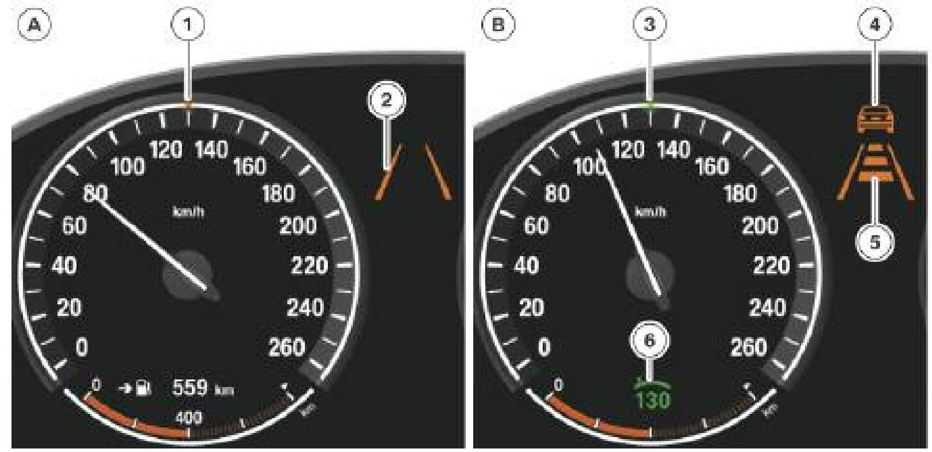
By comparison with DCC, a vehicle with ACC Stop & Go has an MFL button pad that additionally features two buttons for making distance adjustments.



Index	Explanation
1	SET button to activate
2	Button for reducing distance
3	Rocker switch to change set speed
4	Button for increasing distance
5	I/O button for ON/OFF
6	Resume button

Each (short) button stroke to change the distance increases the desired distance used by ACC Stop & Go for its control process by one increment at a time. A total of four increments are available to the driver.

If the vehicle is equipped with the head-up display option, the ACC displays also appear there, provided the driver has configured them to do so.



Index	Explanation
A	"Standby" state
B	"Active" state
1	Orange LED: set speed of 130 km/h stored
2	Lines that indicate "standby" mode
3	Green LED: set speed of 130 km/h selected by the driver (the speedometer needle is not pointing at the LED here because the vehicle in front is travelling slower than the set speed)
4	Car symbol: vehicle ahead detected by ACC Stop & Go
5	Bars: represent the distance increment selected by the driver
6	Set speed displayed numerically: briefly displayed at the time of function activation or whenever the set speed is changed

Behavior in response to the driver's intention to get out
ACC Stop & Go uses the DSC hydraulics to reliably slow the vehicle to a halt and keep it stationary.

Without a supply of electricity, the DSC hydraulics are, however, unable to indefinitely maintain the braking force necessary to keep the vehicle stationary.

By contrast with the E6x LCI, the F01/F02 is equipped with an electromechanical parking brake (EMF). This is able to assume the function of holding the vehicle stationary if

- DSC is no longer able to maintain the hold function due to a fault or overload,
- the driver gets out or
- the engine is switched off.

Thanks to the EMF, ACC Stop & Go also benefits from improvements designed to enhance comfort while the vehicle is stationary. Drivers of an E6x LCI had to be issued with a warning if they were about to get out with ACC Stop & Go still active. They were reminded to secure the vehicle against rolling away. They had to apply the parking brake manually.

In the F01/F02, however, the parking brake function of the EMF is activated automatically whenever the driver is about to get out of the vehicle with ACC Stop & Go still active.

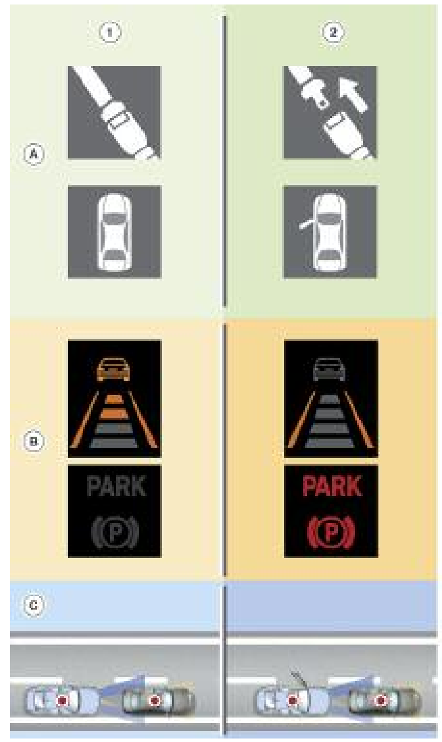
The driver's intention to get out of the F01/ F02 is detected by the signals of the seat belt buckle contact (driver's) and door contact (driver's door). A signal from the seat occupancy detection (driver's seat) is not used in the F01/F02.

While the vehicle is being held stationary by ACC Stop & Go, the DSC unit takes over all monitoring and control processes.
The DSC also controls the system's behavior in response to the driver's intention to get out of the vehicle.

For ACC Stop & Go, this is absolutely identical to that implemented for the DSC-internal Automatic Hold function.

ACC Stop & Go is deactivated automatically if, from the bus signals it receives, it detects that the parking brake function has been activated.

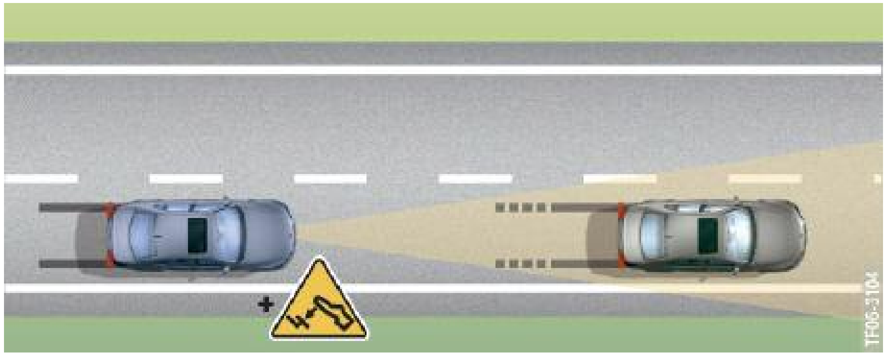
Now the vehicle is still held stationary but by the parking brake function instead.



Index	Explanation
A	State of driver's seat belt and driver's door
B	Displays of ACC Stop & Go and parking brake in the instrument cluster
C	Road traffic situation or perceptible response of vehicle with ACC Stop & Go
1	ACC Stop & Go is active and has automatically braked the vehicle to a halt behind a vehicle in front.
2	The DSC hydraulics hold the vehicle stationary (and are monitored by the DSC control unit).

Adaptive Brake Assistant with Warning Function

The Adaptive Brake Assistant has been carried over from the E6x LCI. This function is included automatically if the customer orders the ACC Stop & Go option.



Adaptive Braking Assistance offers the greatest benefit in situations where the vehicle is following another vehicle. If the vehicle in front brakes hard, it is detected by the long range radar sensor.

The two subfunctions of precharging the brake system (also known as the "brake readiness" function) and lowering the threshold for the hydraulic Brake Assistant, assist the driver to perform the braking operation to best effect and thus in the best case to avoid a rear-end collision with the vehicle in front.

In the F01/F02, this function is no different from the function implemented in the E6x LCI. The long-range radar sensor gathers data on the road users ahead of the vehicle. The data are supplemented by data relating to the driving status of the customer's vehicle, and both types of data are used as a basis for calculating a collision avoidance rate of deceleration.

This is the rate of deceleration at which the driver would have to brake in order to avoid a collision with the vehicle in front. If the calculated collision avoidance deceleration is above a stored threshold value, the brake system begins to precharge and the activation threshold for the hydraulic Brake Assistant is reduced.

All sensor-related and processing functions of Adaptive Braking Assistance are computed in the long-range radar sensor. However, the computed output variables have to be transmitted to the DSC control unit because that is where they are put into action.

To make this possible, the ICM control unit acts as a gateway between the local CAN and the FlexRay.

In the DSC control unit, there are still more conditions that need to be fulfilled before these two subfunctions can be carried out.

(Example: road speed must be higher than a defined minimum speed.)

However, the Adaptive Braking Assistance technology also has limits and cannot react fast enough in situations such as other road users cutting in right in front of the vehicle.

Driving with care and anticipation remains the fundamental imperative even with Adaptive Braking Assistance!

The Adaptive Brake Assistant and its subfunctions are always active and do not have to be switched on separately by the driver.

New warning function

In the F01/F02, the Adaptive Brake Assistant is supplemented by a warning function. This useful "collision warning" is designed to draw the driver's attention to hazardous situations in good time. The driver is then assisted by the subfunctions of the Adaptive Brake Assistant, which provide optimum deceleration in this kind of emergency situation.

The driver is able to switch the collision warning on and off. Its state (on/off) remains stored for the duration of the current driving cycle (key-specific).

The field of application in which the collision warning offers the greatest benefit to the customer is as follows: The customer is driving behind a vehicle that brakes suddenly and hard.

If the customer has activated the collision warning, he is given notification in two stages that a hazardous situation has been detected and the customer is thereby prompted to intervene:

- Advance warning
- Acute warning.

The time at which the warning has to be issued is, again, calculated by the long-range radar sensor based on the collision avoidance deceleration. Each warning stage has its own threshold values.

Setting the advance warning

In the event of an advance warning, powerful braking by the driver is sufficient to avoid the situation. If the acute warning is issued, the driver must brake immediately and with maximum force to avoid a collision.

The driver has some control over the threshold value for the activation of the first stage, the advance warning. From an Assistant window in the Central Information Display, the driver is able to select one of three warning times for the advance warning:

- Early
- Late
- Off (no advance warning given).

For the collision warning, the ICM control unit is responsible for the following control tasks. The switching on and off, the activation conditions, the fault monitoring and the adjustment of the warning time are all computed by the ICM.

In addition, the ICM control unit forwards the warning request from the long-range radar sensor to the instrument cluster and (if fitted) the head-up display, where the warning is issued.

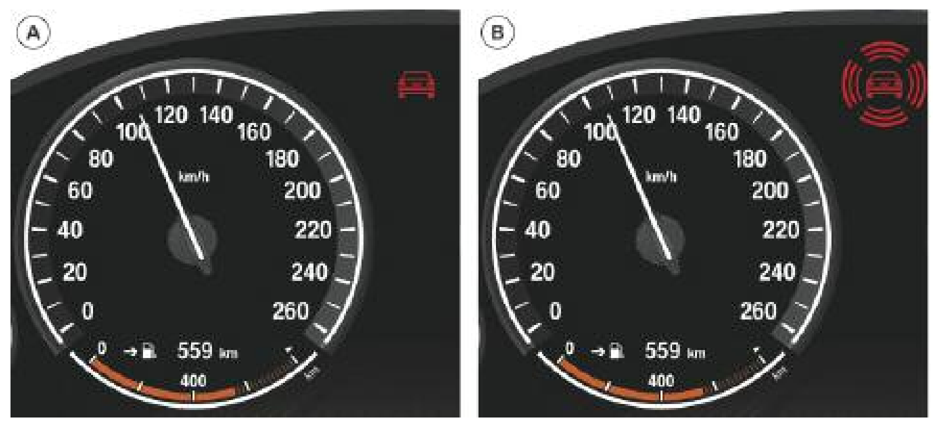
Issuing of the warning

The advance warning is represented by the red car symbol in the instrument cluster. In the event of an advance warning, it lights up constantly. As there is no audible signal, this visual warning signal is the only signal for the advance warning.

In the event of an acute warning, the car symbol in the instrument cluster begins to flash. Since an immediate intervention by the driver is required, this visual signal is supplemented by an audible tone.

This particular high-frequency tone is used only for the acute warning and differs distinctly from other tones that are issued, e.g. with Check Control messages.

If the vehicle is equipped with the head-up display, the visual displays of the collision warning are seen by the driver even more directly and therefore even sooner.



Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

In the head-up display, the advance warning is represented by a significantly enlarged red car symbol. As with the instrument cluster display, the advance warning is indicated by the symbol lighting up constantly.

Index	Explanation	Index	Explanation
A	Stage 1: Advance warning	B	Stage 2: Acute warning

In the event of an acute warning, the car symbol in the head-up display begins to flash.

At the same time, the parts of the display that are irrelevant to this emergency situation are hidden so as not to distract the driver unnecessarily. These displays include those of the navigation system, for example. As soon as the acute warning is over, all the displays in the head-up display re-appear.

The same distinctive tone for the acute warning is used in vehicles with head-up display.

The collision warning is active only if the driver has switched it on at the driver assistance systems operating unit.

As the advance warning is the first warning stage, its timing is configurable but it can also be switched off.

Fault states

The functions of the Adaptive Brake Assistant depend on the faultless operation of the long range radar sensor in particular, but also of the ICM control unit and the DSC unit.

If one of these essential system components is limited in its availability in any way, these functions may no longer work correctly and would need to be deactivated.

The driver is given notification of this condition. If, for example, a fault is present at the time the system is switched on, the function illumination of the collision warning will not be activated.

From this, the driver can infer that the collision warning is not available. If a fault were to occur some time after the system was switched on, the driver could fail to see the function illumination go out. For this reason, a Check Control message is issued as an additional warning measure.

There are two different symbols, and each one is supplemented by a relevant instruction. Collision warning deactivated (due to unfavorable operating conditions, e.g. dirty long-range radar sensor) Collision warning failure (due to genuine faults or defective components).

	
Collision warning deactivated (due to unfavorable operating conditions e.g. dirty long range radar sensors)	Collision warning failure (due to genuine faults or defective components)

Components for ACC Stop and Go

Long-range radar sensor

In terms of physical design, the long-range radar sensor (LRR) for ACC Stop & Go in the F01/F02 is largely identical to the one fitted in the E6x LCI.

Functionally, however, it differs from the sensor in the E6x LCI in that it also calculates the new collision warning of the Adaptive Brake Assistant.

In the F01/F02, the long-range radar sensor no longer has a connection to the wake-up line. Instead, it is supplied with power by terminal 15N and is thus hard switched.

Terminal 15N is tapped off at the front fuse carrier. The long-range radar sensor contains a terminating resistor (for the local CAN) as it does in the E6x LCI.

The installation location of the long-range radar sensor and the way it is mounted have been adapted to the structural conditions specific to the F01/F02.

Index	Explanation	Index	Explanation
1	Fixed bearing (mount)	4	Housing
2	Connector	5	Screw for vertical adjustment
3	Screw for horizontal adjustment	6	Bracket

Short-range radar sensors

The short-range radar sensors (SRR) used for ACC Stop & Go in the E6x LCI have undergone a hardware revision. New, integrated switch circuits have been implemented.

The principle of operation, however, is much the same. The short-range radar sensors on the left and right are identical, as they are in the E6x LCI.

Each of the short-range radar sensors detects its respective installation position from the pin that is assigned to ground in the wiring harness.

Index	Explanation	Index	Explanation
1	Bracket	3	Housing (antenna cover)
2	Connector		

As in the E6x LCI, the short-range radar sensors cannot be programmed. While they do have a self-diagnostics function, accessing the ICM control unit is the only means by which it is possible to read their fault code memory entries.

In the F01/F02, the short-range radar sensors - like the long-range radar sensor - are supplied with power by terminal 15N, which is supplied in turn by the front fuse carrier.

There is no connection to the wake-up line. The local CAN is connected to the short range radar sensors by two lines, which begin at the long-range radar sensor.

The short-range radar sensors have no terminating resistor for the local CAN.

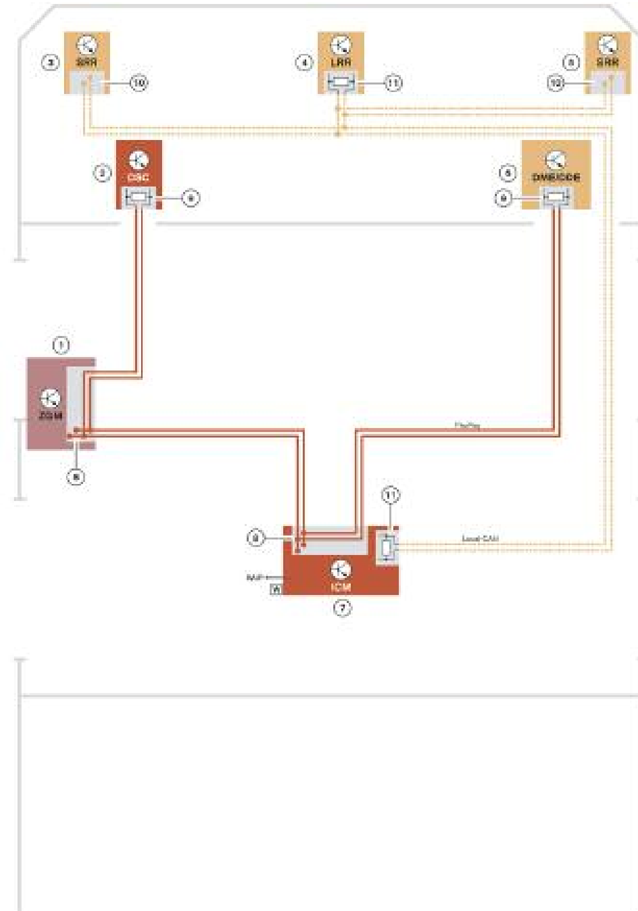
In the F01/F02, the short-range radar sensors are fitted on top of the bumper carrier (and no longer on its front). For this reason, the bracket had to be completely redesigned. It now grips the housing of the short-range radar sensor from behind.

To guarantee the necessary level of stability and reliability, the bracket now also has a reinforcement rib. This runs vertically to the front of the aerial cover. The rib was positioned here in order to minimize its interference with the propagation of radar waves.

The material for the bracket (and thus for the rib) was also selected specifically for this particular application. Emergency repairs that use other plastic parts are not permitted.

Otherwise, there is a risk that the short-range radar sensors may not work correctly.

Note: The short range radar sensors (if replaced) must be commissioned via the diagnostic system after installation. The sensors are accessed through the pathway provided by the ICM via the Lo-CAN.



Index	Explanation	Index	Explanation
1	ZGM	7	ICM
2	DSC	8	FlexRay bus
3	Short range radar sensor, left	9	FlexRay terminating resistor, DSC and DME
4	Long range radar sensor	10	Lo-CAN bus termination
5	Short range radar sensor, right	11	Lo-CAN terminating resistor
6	DME		

Driver Assistance Systems Operating Unit
The driver assistance systems operating unit contains a button for switching the collision warning on and off. The operating unit is connected to the footwell module (FRM) on the LIN bus.

A bus signal from the FRM notifies the ICM control unit when the button has been pressed.

Index	Explanation
1	Function illumination
2	Button for warning of Adaptive Brake Assistant

The ICM does not allow the collision warning to switch on unless the entire system is working faultlessly. It is only then that a bus signal providing positive feedback is sent to the FRM in order to have the function illumination in the button light up.

If, however, a fault is present in any part of the entire system, the function illumination remains off even if the button is pressed. From this, the driver can infer that the collision warning is not available.

Multifunction steering wheel button pad
Which version of the MFL button pad on the left-hand spoke of the multifunction steering wheel is fitted depends on which option, DCC or ACC Stop & Go, is fitted in the vehicle.

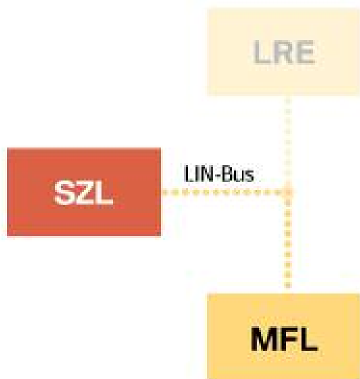
This does not apply to the MFL button pad on the right-hand spoke, which is the same regardless of whether the vehicle is equipped with DCC or ACC Stop & Go.

The operation and function of the buttons were described in the "functions" section.

The electronics of the multifunction steering wheel evaluate the button strokes on both MFL button pads. On the LIN bus, the signals are transmitted to the steering column switch cluster (SZL).

The SZL forwards the button stroke signals to the ICM control unit on the FlexRay. This is where the signals for controlling the DCC and ACC Stop & Go function are evaluated.

There is no function illumination on the MFL button pad. For this reason, no feedback is sent by the ICM control unit to the MFL button pad as it is to the driver assistance systems operating unit.



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